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The United States Air Force Summer Research Program (USAF-SRP) is designed to introduce university, college, and technical institute faculty members, graduate students, and high school students to Air Force research. This is accomplished by the faculty members, graduate students, and high school students being selected on a nationally advertised competitive basis during the summer intersession period to perform research at Air Force Research Laboratory (AFRL) Technical Directorates and Air Force Air Logistics Centers (ALC). The management volume consists of a program overview, program management statistics, a listing of the participants, and an abstract for each participants summer research.

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UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1994

MANAGEMENT VOLUME

VOLUME 1

RESEARCH & DEVELOPMENT LABORATORIES

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Bolling Air Force Base

Washington, D.C.

December 1994

PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

This document is one of a set of 16 volumes describing the 1994 AFOSR Summer Research Program. The following volumes comprise the set:

VOLUME	TITLE
1	Program Management Report
	Summer Faculty Research Program (SFRP) Reports
2A & 2B	Armstrong Laboratory
3A & 3B	Phillips Laboratory
4	Rome Laboratory
5A & 5B	Wright Laboratory
6	Arnold Engineering Development Center, Frank J. Seiler Research Laboratory, and Wilford Hall Medical Center
	Graduate Student Research Program (GSRP) Reports
7	Armstrong Laboratory
8	Phillips Laboratory
9	Rome Laboratory
10	Wright Laboratory
11	Arnold Engineering Development Center, Frank J. Seiler Research Laboratory, and Wilford Hall Medical Center
	High School Apprenticeship Program (HSAP) Reports
12A & 12B	Armstrong Laboratory
13	Phillips Laboratory
14	Rome Laboratory
15A&15B	Wright Laboratory
16	Arnold Engineering Development Center

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1. INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty, graduate students, and high school students to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines using laboratory facilities and equipment not often available at associates' institutions.

AFOSR also offers its research associates an opportunity, under the Summer Research Extension Program (SREP), to continue their AFOSR-sponsored research at their home institutions through the award of research grants. In 1994 the maximum amount of each grant was increased from $20,000 to $25,000, and the number of AFOSR-sponsored grants decreased from 75 to 60. A separate annual report is compiled on the SREP.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members with at least two years of teaching and/or research experience in accredited U.S. colleges, universities, or technical institutions. SFRP associates must be either U.S. citizens or permanent residents.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or a master's degree; GSRP associates must be U.S. citizens enrolled full time at an accredited institution.

The High School Apprentice Program (HSAP) annually selects about 125 high school students located within a twenty mile commuting distance of participating Air Force laboratories.

The numbers of projected summer research participants in each of the three categories are usually increased through direct sponsorship by participating laboratories.

AFOSR's SRP has well served its objectives of building critical links between Air Force research laboratories and the academic community, opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest; and strengthening the nation's efforts to sustain careers in science and engineering. The success of the SRP can be gauged from its growth from inception (see Table 1) and from the favorable responses the 1994 participants expressed in end-of-tour SRP evaluations (Appendix B).

AFOSR contracts for administration of the SRP by civilian contractors. The contract was first awarded to Research & Development Laboratories (RDL) in September 1990. After completion of the 1990 contract, RDL won the recompetition for the basic year and four 1-year options.

2. PARTICIPATION IN THE SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the number of associates in the program each year.

Table 1: SRP Participation, by Year

YEAR	Number of Participants			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444
1992	185	121	159	464
1993	187	117	136	440
1994	192	117	133	442

Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years; in one case a laboratory did not fund <u>any</u> additional associates. However, the table shows that, overall, the number of participating associates increased this year because two laboratories funded more associates than they had in previous years.

3. RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 44-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous (over 600 annually) individual requesters.

Due to a delay in awarding the new contract, RDL was not able to place advertisements in any of the following publications in which the SRP is normally advertised: *Black Issues in Higher Education, Chemical & Engineering News, IEEE Spectrum* and *Physics Today*.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants and participants for 1994 are shown in this table.

Table 2: 1994 Applicants and Participants

PARTICIPANT CATEGORY	TOTAL APPLICANTS	SELECTEES	DECLINING SELECTEES
SFRP (HBCU/MI)	600 (90)	192 (16)	30 (7)
GSRP (HBCU/MI)	322 (11)	117 (6)	11 (0)
HSAP	562	133	14
TOTAL	1484	442	55

4. SITE VISITS

During June and July of 1994, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

In previous years, an RDL program representative visited from seven to ten different HBCU/MIs to promote interest in the SRP among the faculty and graduate students. Due to the late contract award date (January 1994) no time was available to visit HBCU/MIs this past year.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates. This year, seven HBCU/MI SFRPs declined after they were selected. The following table records HBCU/MI participation in this program.

Table 3: SRP HBCU/MI Participation, by Year

YEAR	SFRP		GSRP	
	Applicants	Participants	Applicants	Participants
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6

6. SRP FUNDING SOURCES

Funding sources for the 1994 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1994 SRP selected participants are shown here.

Table 4: 1994 SRP Associate Funding

FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	150	98*1	121*2
USAF Laboratory Funds	37	19	12
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	5	0	0
TOTAL	192	117	133

*1 - 100 were selected, but two canceled too late to be replaced.
*2 - 125 were selected, but four canceled too late to be replaced.

7. COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

Table 5: 1994 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994
Faculty Members	$690	$718	$740	$740
Graduate Student (Master's Degree)	$425	$442	$455	$455
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391
High School Student (First Year)	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $50/day for faculty and $37/day for graduate students. Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and GSRP associates, 58% (178 out of 309) claimed travel reimbursements at an average round-trip cost of $860.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-one percent (78 out of 192) of faculty associates took orientation trips at an average cost of $498. Many faculty associates noted on their evaluation forms that due to the late notice of acceptance into the 1994 SRP (caused by the late award in January 1994 of the contract) there wasn't enough time to attend an orientation visit prior to their tour start date. In 1993, 58 % of SFRP associates took orientation visits at an average cost of $685.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8. CONTENTS OF THE 1994 REPORT

The complete set of reports for the 1994 SRP includes this program management report augmented by fifteen volumes of final research reports by the 1994 associates as indicated below:

Table 6: 1994 SRP Final Report Volume Assignments

	VOLUME		
LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, FJSRL, WHMC	6	11	16

AEDC = Arnold Engineering Development Center
FJSRL = Frank J. Seiler Research Laboratory
WHMC = Wilford Hall Medical Center

APPENDIX A -- PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP and GSRP associates represent 158 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 46 states plus Washington D.C. and Puerto Rico. Selectees represent 40 states.

GSRP - Applicants came from 46 states and Puerto Rico. Selectees represent 34 states.

HSAP - Applicants came from fifteen states. Selectees represent ten states.

C. Academic Disciplines Represented

The academic disciplines of the combined 192 SFRP associates are as follows:

Electrical Engineering	22.4%
Mechanical Engineering	14.0%
Physics: General, Nuclear & Plasma	12.2%
Chemistry & Chemical Engineering	11.2%
Mathematics & Statistics	8.1%
Psychology	7.0%
Computer Science	6.4%
Aerospace & Aeronautical Engineering	4.8%
Engineering Science	2.7%
Biology & Inorganic Chemistry	2.2%
Physics: Electro-Optics & Photonics	2.2%
Communication	1.6%
Industrial & Civil Engineering	1.6%
Physiology	1.1%
Polymer Science	1.1%
Education	0.5%
Pharmaceutics	0.5%
Veterinary Medicine	0.5%
TOTAL	100%

Table A-1. Total Participants

Number of Participants	
SFRP	192
GSRP	117
HSAP	133
TOTAL	442

Table A-2. Degrees Represented

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	189	0	189
Master's	3	47	50
Bachelor's	0	70	70
TOTAL	192	117	309

Table A-3. SFRP Academic Titles

Academic Titles	
Assistant Professor	74
Associate Professor	63
Professor	44
Instructor	5
Chairman	1
Visiting Professor	1
Visiting Assoc. Prof.	1
Research Associate	3
TOTAL	192

Table A-4. Source of Learning About SRP

SOURCE	SFRP		GSRP	
	Applicants	Selectees	Applicants	Selectees
Applied/participated in prior years	26%	37%	10%	13%
Colleague familiar with SRP	19%	17%	12%	12%
Brochure mailed to institution	32%	18%	19%	12%
Contact with Air Force laboratory	15%	24%	9%	12%
Faculty Advisor (GSRPs Only)	--	--	39%	43%
Other source	8%	4%	11%	8%
TOTAL	100%	100%	100%	100%

Table A-5. Ethnic Background of Applicants and Selectees

	SFRP		GSRP		HSAP	
	Applicants	Selectees	Applicants	Selectees	Applicants	Selectees
American Indian or Native Alaskan	0.2%	0%	1%	0%	0.4%	0%
Asian/Pacific Islander	30%	20%	6%	8%	7%	10%
Black	4%	1.5%	3%	3%	7%	2%
Hispanic	3%	1.9%	4%	4.5%	11%	8%
Caucasian	51%	63%	77%	77%	70%	75%
Preferred not to answer	12%	14%	9%	7%	4%	5%
TOTAL	100%	100%	100%	100%	99%	100%

Table A-6. Percentages of Selectees receiving their 1st, 2nd, or 3rd Choices of Directorate

	1st Choice	2nd Choice	3rd Choice	Other Than Their Choice
SFRP	70%	7%	3%	20%
GSRP	76%	2%	2%	20%

APPENDIX B -- SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	275
HSAPs	116
USAF Laboratory Focal Points	109
USAF Laboratory HSAP Mentors	54

All groups indicate near-unanimous enthusiasm for the SRP experience.

Typical comments from 1994 SRP associates are:

> "[The SRP was an] excellent opportunity to work in state-of-the-art facility with top-notch people."

> "[The SRP experience] enabled exposure to interesting scientific application problems; enhancement of knowledge and insight into 'real-world' problems."

> "[The SRP] was a great opportunity for resourceful and independent faculty [members] from small colleges to obtain research credentials."

> "The laboratory personnel I worked with are tremendous, both personally and scientifically. I cannot emphasize how wonderful they are."

> "The one-on-one relationship with my mentor and the hands on research experience improved [my] understanding of physics in addition to improving my library research skills. Very valuable for [both] college and career!"

Typical comments from laboratory focal points and mentors are:

> "This program [AFOSR - SFRP] has been a 'God Send' for us. Ties established with summer faculty have proven invaluable."
>
> "Program was excellent from our perspective. So much was accomplished that new options became viable "
>
> "This program managed to get around most of the red tape and 'BS' associated with most Air Force programs. Good Job!"
>
> 'Great program for high school students to be introduced to the research environment. Highly educational for others [at laboratory]."
>
> "This is an excellent program to introduce students to technology and give them a feel for [science/engineering] career fields. I view any return benefit to the government to be 'icing on the cake' and have usually benefitted."

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below (Note: basically the same as in previous years.)

A. Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B. Laboratory sponsor seminar presentations of work conducted by associates, and/or organized social functions for associates to collectively meet and share SRP experiences.

C. Laboratory focal points collectively suggest more AFOSR allocated associate positions, so that more people may share in the experience.

D. Associates collectively suggest higher stipends for SRP associates.

E. Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same arguement was used to raise the faculty and graduate student participation time a few years ago.)

2. 1994 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 109 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ? (% Response)											
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	**Evals Recv'd**	**0**	**1**	**2**	**3+**	**0**	**1**	**2**	**3+**	**0**	**1**	**2**	**3+**
AEDC	10	30	50	0	20	50	40	0	10	40	60	0	0
AL	44	34	50	6	9	54	34	12	0	56	31	12	0
FJSRL	3	33	33	33	0	67	33	0	0	33	67	0	0
PL	14	28	43	28	0	57	21	21	0	71	28	0	0
RL	3	33	67	0	0	67	0	33	0	100	0	0	0
WHMC	1	0	0	100	0	0	100	0	0	0	100	0	0
WL	46	15	61	24	0	56	30	13	0	76	17	6	0
Total	**121**	**25%**	**43%**	**27%**	**4%**	**50%**	**37%**	**11%**	**1%**	**54%**	**43%**	**3%**	**0%**

LFP Evaluation Summary. The summarized repsonses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5 a. Benefits of associate's work to laboratory:
   b. Benefits of associate's work to Air Force:
6. a. Enhancement of research qualifications for LFP and staff:
   b. Enhancement of research qualifications for SFRP associate:
   c. Enhancement of research qualifications for GSRP associate:
7. a. Enhancement of knowledge for LFP and staff:
   b. Enhancement of knowledge for SFRP associate:
   c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10. a. Your working relationship with SFRP:
    b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

(Continued on next page)

12. Quality of program literature for associate:
13. a. Quality of RDL's communications with you:
 b. Quality of RDL's communications with associates:
14. Overall assessment of SRP:

Laboratory Focal Point Reponses to above questions

	AEDC	*AL*	*FJSRL*	*PL*	*RL*	*WHMC*	*WL*
# Evals Recv'd	10	32	3	14	3	1	46
Question #							
2	90 %	62 %	100 %	64 %	100 %	100 %	83 %
2a	**3.5**	**3.5**	4.7	4.4	4.0	4.0	**3.7**
2b	4.0	3.8	4.0	4.3	4.3	4.0	3.9
3	4.2	3.6	4.3	3.8	4.7	4.0	4.0
4	3.8	3.9	4.0	4.2	4.3	NO ENTRY	4.0
5a	4.1	4.4	4.7	4.9	4.3	3.0	4.6
5b	4.0	4.2	4.7	4.7	4.3	3.0	4.5
6a	**3.6**	4.1	**3.7**	4.5	4.3	**3.0**	4.1
6b	3.6	4.0	4.0	4.4	4.7	3.0	4.2
6c	3.3	4.2	4.0	4.5	4.5	3.0	4.2
7a	3.9	4.3	4.0	4.6	4.0	3.0	4.2
7b	4.1	4.3	4.3	4.6	4.7	3.0	4.3
7c	3.3	4.1	4.5	4.5	4.5	5.0	4.3
8	4.2	4.3	5.0	4.9	4.3	5.0	4.7
9	3.8	4.1	4.7	5.0	4.7	5.0	4.6
10a	4.6	4.5	5.0	4.9	4.7	5.0	4.7
10b	4.3	4.2	5.0	4.3	5.0	5.0	4.5
11	4.1	4.5	4.3	4.9	4.7	4.0	4.4
12	4.1	3.9	4.0	4.4	4.7	3.0	4.1
13a	**3.8**	**2.9**	4.0	4.0	4.7	**3.0**	**3.6**
13b	**3.8**	**2.9**	4.0	4.3	4.7	**3.0**	**3.8**
14	4.5	4.4	5.0	4.9	4.7	4.0	4.5

3. 1994 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 275 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from
1 (below average) to 5 (above average)

1. The match between the laboratories research and your field:	4.6
2. Your working relationship with your LFP:	4.8
3. Enhancement of your academic qualifications:	4.4
4. Enhancement of your research qualifications:	4.5
5. Lab readiness for you: LFP, task, plan:	4.3
6. Lab readiness for you: equipment, supplies, facilities:	4.1
7. Lab resources:	4.3
8. Lab research and administrative support:	4.5
9. Adequacy of brochure and associate handbook:	4.3
10. RDL communications with you:	4.3
11. Overall payment procedures:	**3.8**
12. Overall assessment of the SRP:	4.7

13. a. Would you apply again?	Yes:	85%
b. Will you continue this or related research?	Yes:	95%
14. Was length of your tour satisfactory?	Yes:	86%

15. Percentage of associates who engaged in:

a. Seminar presentation:	52%
b. Technical meetings:	32%
c. Social functions:	03%
d. Other	01%

16. Percentage of associates who experienced difficulties in:

a. Finding housing:	12%
b. Check Cashing:	03%

17. Where did you stay during your SRP tour?

a. At Home:	20%
b. With Friend:	06%
c. On Local Economy:	47%
d. Base Quarters:	10%

THIS SECTION FACULTY ONLY:

18. Were graduate students working with you? Yes: 23%

19. Would you bring graduate students next year? Yes: 56%

20. Value of orientation visit:

Essential:	29%
Convenient:	20%
Not Worth Cost:	01%
Not Used:	34%

THIS SECTION GRADUATE STUDENTS ONLY:

21. Who did you work with:

University Professor:	18%
Laboratory Scientist:	54%

4. 1994 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

The summarized results listed below are from the 54 mentor evaluations received.

1. Mentor apprentice preferences:

Table B-3. Air Force Mentor Responses

		How Many Apprentices Would You Prefer To Get ?			
		HSAP Apprentices Preferred			
Laboratory	***# Evals Recv'd***	***0***	**1**	**2**	**3+**
AEDC	6	0	100	0	0
AL	17	29	47	6	18
PL	9	22	78	0	0
RL	4	25	75	0	0
WL	18	22	55	17	6
Total	**54**	**20%**	**71%**	**5%**	**5%**

Mentors were asked to rate the following questions on a scale from
1 (below average) to 5 (above average)

2. Mentors involved in SRP apprentice application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Laboratory's preparation for apprentice:
4. Mentor's preparation for apprentice:
5. Length of research tour:
6. Benefits of apprentice's work to U.S. Air force:
7. Enhancement of academic qualifications for apprentice:
8. Enhancement of research skills for apprentice:
9. Value of U.S. Air Force/high school links:
10. Mentor's working relationship with apprentice:
11. Expenditure of mentor's time worthwhile:
12. Quality of program literature for apprentice:
13. a. Quality of RDL's communications with mentors:
    b. Quality of RDL's communication with apprentices:
14. Overall assessment of SRP:

	AEDC	*AL*	*PL*	*RL*	*WL*
# Evals Recv'd	**6**	**17**	**9**	**4**	**18**
Question #					
2	100 %	76 %	56 %	75 %	61 %
2a	4.2	4.0	**3.1**	**3.7**	**3.5**
2b	4.0	4.5	4.0	4.0	3.8
3	4.3	**3.8**	**3.9**	**3.8**	**3.8**
4	4.5	**3.7**	**3.4**	4.2	**3.9**
5	**3.5**	4.1	**3.1**	**3.7**	**3.6**
6	4.3	3.9	4.0	4.0	4.2
7	4.0	4.4	4.3	4.2	3.9
8	4.7	4.4	4.4	4.2	4.0
9	4.7	4.2	3.7	4.5	4.0
10	4.7	4.5	4.4	4.5	4.2
11	4.8	4.3	4.0	4.5	4.1
12	4.2	4.1	4.1	4.8	3.4
13a	**3.5**	**3.9**	**3.7**	4.0	**3.1**
13b	4.0	4.1	3.4	4.0	3.5
14	4.3	4.5	3.8	4.5	4.1

5. 1994 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 116 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from
1 (below average) to 5 (above average)

1. Match of lab research to you interest:		3.9
2. Apprentices working relationship with their mentor and other lab scientists:		4.6
3. Enhancement of your academic qualifications:		4.4
4. Enhancement of your research qualifications:		4.1
5. Lab readiness for you: mentor, task, work plan		**3.7**
6. Lab readiness for you: equipment supplies facilities		4.3
7. Lab resources: availability		4.3
8. Lab research and administrative support:		4.4
9. Adequacy of RDL's apprentice handbook and administrative materials:		4.0
10. Responsiveness of RDL's communications:		**3.5**
11. Overall payment procedures:		**3.3**
12. Overall assessment of SRP value to you:		4.5
13. Would you apply again next year?	Yes:	88%
14. Was length of SRP tour satisfactory?	Yes:	78%
15. Percentages of apprentices who engaged in:		
a. Seminar presentation:		48%
b. Technical meetings:		23%
c. Social functions:		18%

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WL/ML
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GSRP Participant Data

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PL/WS
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HSAP Participant Data

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WL/PO
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Gudorf, Matthew
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Laboratory: Wright Laboratory
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Guilfoos, Brian
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Hurst, Venessa
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Laboratory: Wright Laboratory
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WL/MN
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AL/AO

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RL/OC

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A PROGRAM PLAN FOR TRANSMITTING HIGH-DATA-RATE ATM/SONET SIGNALS OVER THE ACTS

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Okechukwu Ugweje
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Abstract

The feasibility, desirability and usefulness of Asynchronous Transfer Mode and Synchronous Optical Network transmission protocols over the Advanced Communications Technology Satellite (ACTS) was studied. A program plan for the transmission of Asynchronous Transmission Mode and Synchronous Optical Network signals at high data rates via the ACTS satellite was developed for the U. S. Air Force Rome Laboratory. The high data rate terminals will transmit and receive signals at DS-3 (45 Mbps) and OC-3 (155 Mbps) over the NASA's ACTS.

HIGH CAPACITY OPTICAL COMMUNICATION NETWORKS

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Abstract

Practical, very high speed networks are critical to support the next generation of information technology applications, such as high-performance computing environments, access to vast electronic libraries, and multimedia communication of voice, data, graphics, and video for business, medical, and industrial needs. This research program will design, prototype, and evaluate a multiuser optical communication network based on novel data encoding and decoding technology. This approach successfully meets the challenge of using the enormous bandwidths of optical channels by placing the burden of handling high bit rates on simple optics, rather than on ultrafast electronics or complex laser sources, making practical and economical implementation a real near-term possibility.

The approach is based on spread spectrum encoding in the optical frequency domain. The high bandwidth optical channel allows the assignment of codes to a large number of users, all of whom can access the channel simultaneously, asynchronously, and at different bit rates. User codes are sent and received in parallel, rather than in series, eliminating electronic bottlenecks and preserving the optical bandwidth advantage. Two innovative features of this technique account for its practical and performance advantages. First, the optical source for each user is extremely simple and rugged: a low power laser diode, similar to those in compact disc players, pumping a few meters of doped optical fiber. Second, highly effective data decoders, or smart receivers, based on integrated photodetector arrays and recent communication theory results, permit simultaneous use of the network by many users while maintaining low bit error rates.

The Application Challenge

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Abstract

Grand challenge applications test the limits and benefits of high performance computer (HPC) technology applied to problems of great significance. This focus on the development of a handful of pilot applications is necessary for both developers and potential users. However, the development methods employed to achieve the grand challenge goals are not always useful as general application development models for prospective industrial users. One of the critical questions is, what kind of application development technology would enable rapid growth in HPC applications?

This paper argues that in many important industrial application areas the answer is not in the relentless quest for simplified, "easy-to-use" programming models. Rather, it is more efficient to provide rich, domain specific, model-based programming environments that directly support concepts, relations and model composition principles which are routinely used in the particular application field. Further, it highlights our experience using tools of this type to develop high performance applications while participating in the 1994 SFRP at AEDC.

A Study of Preform Design Problem for Metal Deformation Processes

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1 Abstract

Metal deformation is a complex phenomenon where externally applied forces on the boundary change the external shape and internal material properties. Metal deformation processes such as forging and extrusion are used very widely in industries to fabricate new and complex parts. From the point of view of design for near-net shape manufacturing of parts, the following question becomes very important: *What is the starting metal shape and the time history of externally applied boundary forces/velocities that will transform a given volume of metal to a desired final shape with desired material properties?*

My study focuses on a subset of the above mentioned problem, which is to find out the starting shape of the metal which for a given time history of the externally applied boundary forces/velocities will transform the metal to a desired final shape. This problem is also refered to as the 'Preform Design Problem' by the metal working community. Presently, this problem is addressed using a 'trial and error' approach. An initial shape is assumed by an experienced designer. It is then either modeled within an FEM simulation code or experimented upon in the laboratory to study the resulting final shape. This final shape is used to alter the initial geometry and the process is repeated until the designer is satisfied with the outcome. The following points about this 'trial and error' approach must be noted: (a) the process requires multiple iterations which could cost the designer many man-hours, (b) substitution of the actual experiment by FEM simulation could substantially reduce the design time, however, it is not uncommon for a single FEM run to take more than an hour, (c) for every new part to be fabricated, the 'trial and error' approach must be repeated.

In this study, a new framework is being suggested to address the Preform Design Problem which has the potential to reduce the design cycle time at least ten-fold when compared to FEM in the loop. In this framework, Boundary Element Method (BEM) is used for analysis. This analysis technique is coupled to a gradient based search algorithm for optimization. The BEM is naturally suited for studying the preform design problem since in this method, the discretizations must be done primarily at the boundary while in FEM, the entire domain must be discretized. Due to the need for fewer number of nodes in BEM as compared to FEM, the author believes that BEM has the potential to be a very efficient numerical tool for solving preform design problems.

A summary of my recommendations based on this study are as follows: (1) to develop BEM analysis codes for simulation of planar and axisymmetric deformation processes, (2) to compare the results of BEM code against the existing FEM codes, and (3) to develop a gradient based optimization module for studying and testing preform designs.

INTERFERENCE EXCISION IN SPREAD SPECTRUM USING TIME-FREQUENCY DISTRIBUTIONS

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Abstract

This report deals with the application of time-frequency distributions(TFD) to direct sequence spread spectrum(SS) communication systems. The case studied is that of a jammer with time-varying characteristics. The capability of the newly devised TFDs to properly localize a single as well as multiple component signals in time and frequency permit unbiased low variance estimation of the interference instantaneous frequency under abrupt as well as evolutionary rapidly changing conditions. This estimate is then used to construct a finite impulse response filter which substantially reduces the interference power with a minimum possible distortion of the desired signal. This two step mechanism for interference excision can be viewed as a case of an open loop adaptive filtering. However contrary to the existing techniques of close loop self-tuning linear predictors or open loop adaptive filtering based on fast Fourier transforms, the filter coefficients in the proposed technique are obtained via *time-varying spectral analysis*. Closed form expressions of the improvement of SNR at the receiver correlator output using TFD-based adaptive filtering are derived. Results show that time-frequency representations of signals should be considered as an important tool to immune the SS systems to smart jamming.

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DETERMINATION OF THE OXIDATIVE REDOX CAPACITY OF AQUIFER SEDIMENT MATERIAL BY SPECTROELECTROCHEMICAL COULOMETRIC TITRATION

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and
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Abstract

Methodology was developed for determination of the oxidative redox capacity of aquifer sediment material by the method of spectroelectrochemical coulometric titration. This method involves the measurement of absorbance of sediment particle slurries at the maximum absorption wavelengths of the optically detectable mediator-titrant (reporter) molecules resorufin and methyl viologen as a function of the charge passed in a constant-potential coulometric titration. An approach which was successful for determination of the oxidative redox capacity of a pond sediment rich in organic matter and iron species was extended to an oxidized aquifer sediment material of low organic carbon and iron species content sampled from Columbus Air Force Base, Mississippi. Titration was carried out on diluted, dry-sieved material of particle size smaller than 75 μm diameter, suspended in aqueous, pH 7, 0.1 ionic strength phosphate buffer at 0.0426 % sediment by weight. Blank titration was carried out on a sample of identical composition but in absence of the aquifer material. In both cases, resorufin was reduced first, followed by methyl viologen. There was no perceptible delay between completion of titration of resorufin and the initiation of titration of methyl viologen. This behavior contrasted significantly with the titration of pond sediment of high organic and iron species content, which showed a very significant break between completion of titration of resorufin and initiation of titration of methyl viologen. Based on the uncertainties of measurement, it could be estimated that the upper limit of oxidative redox capacity of the Columbus aquifer material was ca. 3 microequivalents per gram of solid material. This estimate is in the vicinity of the values of redox capacity of aquifer material obtained from other sites by one other research group, but not consistent with the values reported by another group. More precise determination of oxidative redox capacity will require use of methods such as fluorescence which are more immune to the effects of scattered light than absorption spectrophotometry, and will allow higher loading of suspended solids than the current absorbance-based method. Additional studies identified the importance of thermal expansion of aqueous solutions as a cause of oxygen leakage into closed vessels when temperature is not regulated, and demonstrated that huge pressure changes (900 psi over a range of 22 °C) can occur when the temperature of an aqueous sample is allowed to vary by small amounts. Methods were devised to overcome this problem by the combination of a thermoisolation chamber to control the temperature of the sample and exclude oxygen from the titration zone.

On The Mixing Mechanisms In A Pair Of Impinging Jets

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ABSTRACT

An experimental investigation of mixing in sprays formed by the impingement of two water jets is presented. A Patternator is used for the spray characterization. The experimental results reveal that different processes in the pre-atomization and post-atomization regions control the mixing. In the pre-atomization region the turbulent fluctuations in each stream which give rise to a helical disturbance on the jet surface downstream of the injection point are responsible for the segregation of the two liquid streams. The helical disturbances result in crossing of the two streams through each other and poor mixing. The results show that the higher the jet velocity, jet diameter, and the impingement angle, the higher the degree of stream crossing and the lower the extent of mixing. On the other hand the turbulent dispersion in the post-atomization region improves the mixing. Consequently, the extent of mixing increases downstream of the impingement point.

ATB SIMULATION OF DEFORMABLE MANIKIN NECK MODELS

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Abstract

The ATB (Articulated Total Body) is a body dynamic model of the human body used at the Armstrong Aerospace Medical Research Laboratory (AAMRL). The model is used to determine the mechanical response of the human body in different dynamic environments such as aircraft pilot ejection, sled test, etc. The new version of the ATB allows for segments to be treated as deformable bodies for more accurate prediction of dynamic response. However, accurate finite element models of the deformable segments are required for such analysis to be useful. In this study, finite element models of the Hybrid III and II dummy necks are incorporated into the revised version of the ATB model. Quasi-static Hybrid III and II neck simulations and several Hybrid III dynamic head-neck simulations are presented and compared with the experimental results where available. It is shown that the simulation results show good agreement with the available experimental results.

PRE-SCREENING OF SOIL SAMPLES USING A SOLIDS INSERTION PROBE AND MASS SPECTROMETRY

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Abstract

One of the primary difficulties with the analysis of environmental samples are the procedures used for the extraction of the target compounds from the sample matrix. It would be advantageous if samples that did not contain target compounds above the minimum detection limits stipulated by the United States Environmental Protection Agency could be identified before they were subjected to the entire extraction process. Our goal is to investigate and develop the use of a solids insertion probe coupled with a quadrupole mass spectrometer for the pre-screening of samples before they are subjected to extraction procedures.

Using sea sand to simulate the soil matrix, we have begun to examine the specific solids probe conditions and temperature profiles necessary for the pre-screening of samples. We have also examined minimum detection limits attainable using this technique.

CALCULATION OF HEATING AND TEMPERATURE DISTRIBUTIONS IN ELECTRICALLY EXCITED FOILS

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ABSTRACT

A finite element analysis of the transient thermal and electrical distributions in electrically exploded thin copper foils to the point of melt is presented. The research focuses on an analysis of a novel system that is currently under development for use in future experiments. All simulations are based on the intrinsic characteristics of copper and require only a two dimensional solution due to the planar nature of the foil's geometry. The simulated behavior shows trends observed in measurements of similar configurations. Specifically, the thermal enhancement observed at abrupt changes in the foils edge geometry.

RAT PUP ULTRASONIC VOCALIZATIONS:
A SENSITIVE INDICATOR OF TERATOGENIC EFFECTS

Suzanne C. Baker
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Abstract

The ultrasonic vocalizations (UVs) normally emitted by rats in contexts which are assumed to be stress-inducing have been shown to be sensitive to the effects of various neuroactive substances. These vocalizations have been utilized by researchers as behavioral indicators of stress or emotionality, and they have provided a useful animal model of anxiety for the investigation of the effects of various anxiogenic and anxiolytic drugs. The research literature on ultrasonic vocalizations emitted by preweanling rats was reviewed in order to explore the potential usefulness of this behavior in testing teratogenic and toxicological effects of various substances using infant rats as subjects. Behavioral and methodological factors important in the use of these calls in research paradigms were identified.

ANOMALOUS EFFECTS OF WATER IN FIRE FIGHTING: INTENSIFICATION OF HYDROCARBON FIRES BY AZEOTROPIC DISTILLATION AND FREE RADICAL EFFECTS

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ABSTRACT

We have shown that water, when applied to burning fuels, substantially increases fuel vaporization rates as a result of azeotropic "steam distillation" effects. Water-induced hot fuel volatility effects are particularly enormous for low volatility (high boiling point) fuels such as JP-8, JP-5 and Jet A-1. Correspondingly severe problems in fire fighting efforts could thus result for fully developed fires involving JP-8 type fuels being extinguished by water fog, AFFF, or other water based extinguishing agents or systems. The effect is not significant for fires involving fuel floating on significant volumes of water. Since almost all large scale training and research fires are conducted in fire pit facilities using tanks of water on which the fuel is floated, this effect has not heretofore been observed in such exercises. Evidence has been found, however, in at least one large serious fire, for very pronounced increases in fire intensities which rationally could have been ascribed to azeotroping effects.

Other, chemical, effects may possibly be operational in these instances. Since the only likely chemical candidates would involve free radical intermediacies, spectroscopic experiments were performed to examine possible free radical pathways.

With increasing emphasis on use of low-volatility JP-8, an importance exists for assessing magnititude of the effect for large scale real-life fires, and for developing countermeasures for obviating this effect; and for developing realistic training exercises to demonstrate the effect and appropriate countermeasures.

Development of Large Parallel Instrumentation Systems

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Abstract

Parallel instrumentation systems, such as the AEDC CADDMAS system, are in high demand. Unfortunately, these systems are also very complex and difficult to construct and manage. The combination of parallel processing and real-time constraints force high system complexity. Standard techniques are inadequate to deal with these systems.

Model-based techniques have been proven to deal with large system complexities. We apply model-based techniques to construct large-scale parallel systems in short development times. The abstractions used througout the entire modeling system are very imporant to the success of the technique. The work described here deals with the low-level abstractions necessary for a real-time kernel in the modeling approach.

RFSIG Target Model Integrated With the Joint Modeling and Simulation System (J-MASS) Environment

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Abstract

As attested to in last summer's report, the J-MASS architecture is a relatively new modeling system designed to support engineers, model developers, analysts and decision makers. J-MASS is written in the object-oriented DOD-standard Ada language. It is designed to be transportable between different J-MASS compliant hardware configurations and to operate on workstations using a Posix-compliant Unix operation system. The current beta test site 2.0 J-MASS release provides almost total functionality through the system environment, allowing a user to log onto J-MASS and develop components, assemble them into models, configure a simulation scenario and place players within the scenario, execute the simulation, and analyze the results through post-processing. Currently, the WL/MNSH and WL/MNMF branches have tested the 3DOF missile code under the J-MASS architecture, and plans have begun for creation of the 6DOF code into the recommended architecture.

My tasks this summer were to rewrite the statistical target model currently written in Fortran into Ada. Also, I worked on an Ada shell which allows for the passing of data from a fortran program to an Ada program. This involved such considerations as reading the Ada boolean "True" or "False" and converting it to the Fortran boolean "1" or "0" respectively. The reason for the writing of the shell was to provide a means for an already fortran program to function in conjunction with other programs written in Ada. If time permitted, I was to perform Monte Carlo analyses on data on a sun workstation. The analyses had been performed on a VAX system, but had not been attempted on a SUN workstation.

The above tasks consisted of understanding of the statistical target model, programming in the Ada language, and a fairly good understanding of J-MASS. The first few weeks I spent studying the model, the next couple working on the shell, and the remaining weeks I devoted to writing, compiling, and debugging of the newly written Ada version of the statistical target model. The last task was carried out in two parts. First, the programs were written and compiled on a VAX system, and then the code was transported to a Sun workstation for compilation.

MULTIGRID METHOD FOR LARGE SCALE ELECTRONIC STRUCTURE OF MATERIALS

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Abstract

A novel method for density functional theory calculations was developed. The Kohn-Sham equations were solved entirely in coordinate space using a finite difference algorithm. The method employed the recently developed multigrid algorithm for solving both the Poisson equation and the electronic variational problem. Order of magnitude accelerations were obtained relative to solution on the finest grid alone. Numerical examples are presented for atomic problems. If the orbitals are localized, the method scales linearly with the number of electrons. Therefore, it holds promise for large scale *ab initio* simulations of materials. Future applications to computation of nonlinear optical properties are discussed.

RADIATION CHARACTERIZATION OF COMMERCIALLY PROCESSED 1.2 MICRON CMOS DEVICES

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Abstract

This paper describes a program to study the effects of ionizing radiation on integrated circuits which were fabricated using standard commercial Complementary Metal Oxide Semiconductor (CMOS) processing steps. A test chip was designed using a hardened circuit design methodology which yield radiation tolerant IC's when using a standard commercial CMOS fabrication process such as resident in a facility such as a MOSIS IC foundry. Several CMOS test circuits and a variety of P and N-channel MOS devices were irradiated up to dose levels of 300krad(SiO2) at a dose rate of 100 rad/sec in accordance with MIL-STD-883D, Test Method 1019.4 and ASTM F-1467. A 10keV mean energy X-ray source was used to provide an ionizing radiation environment. Radiation test data is presented on the three circuits - a 21 gate delay chain, an XROM sense amplifier and a 4-bit shift register. All test circuits operate effectively through 100krads and show less than 20% degradation after 300krads. Reentrant (annular) structures show very little threshold shift or leakage current after 300krads. Edge transistors show little threshold shift at 100krads with increasing shifts up to 0.3 volts at 300krads with leakage currents increasing several orders of magnitude up to 1 nanoamp. Field oxide devices show significant leakage current after 100krads and are the limiting factors in applying commercial processes to radiation tolerant IC's.

DESIGNING SOFTWARE BY REFORMULATION USING KIDS

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Abstract

In recent years, much attention has been paid to designing software by formal methods. Such an approach has been shown to facilitate the design of correct software. The KIDS system utilized at Rome Laboratory is an example of a software design system based entirely on a formal approach - the theory of institutions developed by Joseph Goguen and his coworkers. KIDS combines a theory of problem solving with a domain theory to derive a high-level program, which can then be transformed to improve efficiency. Frequently, the problem solving theory is a theory of global search, as it is in the KTS transportation scheduling system. Unfortunately, although global search through the space of possible solutions may be suitable for some problems, it is extremely inefficient for many others. In many problems, the search space is far too large for such an approach. Rather, it is desirable to decompose the space into independent components, so that partial solutions can be found in each piece and combined to give a global solution. KIDS does support problem space decomposition, but does not provide methods for finding useful decompositions for specific problems. This paper describes how a theory of decomposition and reformulation can be used in conjunction with KIDS to derive efficient programs.

Diffusional Creep in Metals and Ceramics at High Temperatures

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Abstract

The theory of diffusional creep created by Nabarro, Herring, Cable and Lifshitz is reexamined and extended to the nonlinear case in order to take into account such nonlinear phenomena as grain rotations and grain boundary migration. The obtained system of equations allows one to analyze "on a microscopical level" void formation, superplasticity, creep of metals and ceramics at low stresses and high temperatures.

THE APPLICATION OF QUADRATIC PHASE CODING TO OTH RADAR SIGNALS

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ABSTRACT

High-frequency radio waves reflected from the Earth's ionosphere can be used to illuminate targets that are several thousand kilometers from the transmitter. Much of the early research and development of this over-the-horizon (OTH) technique was conducted during the 1950s at the Air Force Rome Laboratory (then called the Rome Air Development Center) and at the Naval Research Laboratory. Today, OTH radar technologies play a central role in the DoD Counterdrug Program, where the primary mission is the detection of small targets with relatively low radial velocity. The ionosphere, however, is a highly variable medium containing a wide range of irregularities, whose structure and behavior is dependent on many factors. In many situations, these irregularities can have a deleterious effect on the signals received by HF OTH radar systems. Although ionospheric plasma irregularities are present to some degree at all latitudes, they are most prevalent at night and in the equatorial and auroral regions. Their effect is to broaden the Doppler spectrum of the backscattered clutter which in turn masks the signature of low-velocity targets with small radar cross section. Several strategies have been proposed to mitigate the effect of these irregularities but no satisfactory solution has yet been adopted for operational systems. One possible solution to this problem is the application of phase encoding of the transmitted signal and the appropriate decoding of the received backscatter echoes. The implementation of this solution was carried out by Decision-Science Applications, Inc. under contract to Rome Laboratory and the first experimental field tests were carried out in June and July of 1994 using in-house facilities. This report discusses some of the initial results obtained during these field tests.

POLYETHERIMIDE FIBERS: PRODUCTION PROCESSING AND CHARACTERIZATION

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Abstract

Polyetherimide is a copolyimide, which unlike most polyimides which are thermosets is a thermoplastic polymer. This means that polyetherimide can be melt spun. A melt spinning set-up was built to produce fibers from this polymer. Polyetherimide fibers were produced in different diameters by melt spinning of the Ultem resin. The as-spun fibers were subsequently drawn to different extents to achieve required diameters. The fibers were characterized for fiber diameter, as well as mechanical and thermal properties. Also, fibers spun from the same resin at other facilities were characterized. Shrinkage behavior of these fibers and their usefulness in fabrication of certain products was studied.

The fibers showed a significant amount of shrinkage tendency depending on the conditions of processing. It was shown that the shrinkage tendency of PEI can be significantly reduced by heat setting. The tensile properties indicated that the fiber can be drawn further by the appropriate selection of drawing temperatures and rates. It was also observed that the thermomechanical response of the fibers was dependent on their processing history.

UNIVERSAL GRAPHICAL USER INTERFACE FOR
TURBINE ENGINE SIMULATION PROGRAMS

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Abstract

Simulation of turbine engines is an important part of the engine test process at AEDC. Traditionally, these simulations have been developed in the FORTRAN language with character oriented user interfaces. Increasing demands in terms of simulation performance, accuracy and model development time necessitate the introduction of graphical user interfaces for these simulations. This paper describes two initial attempts to add such user interfaces to existing engine modeling codes. Based on the experience gained with these conversions, a universal graphical user interface is developed which promises to ease the conversion of other, similar FORTRAN engine simulation programs.

PRACTICAL SEMIQUANTAL MODELLING OF COLLISIONAL VIBRATIONAL RELAXATION OF DIATOMIC MOLECULES

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Abstract

To model and interpret emission spectra and energy bugeting in infrared-active molecules in the atomsphere, such as OH and NO, the rates for vibrational relaxation through collisions must be known. This project successfully produced practical, easily applied semiquantal analytic formulae that accurately simulated relaxation rates determined both by brute-force quantum mechanical computations (e.g., HF(n) + He) and also by laboratory measurements (e.g., OH(n) + O_2). The one-parameter required for the semiquantal expressions (the exponential slope of the collisional repulsive core) can be determined for a specific collision system from a known interaction potential or, as is usually the case, from a limited set of experimental rates. In all systems studied, the one-parameter fits passed through all error bars. These handy expressions were also able to predict the extreme sensitivity of relaxation rates to molecular anharmonicity and collisional temperature, accurately tracking the rates over changes of many order of magnitude. Furthermore, a perturbation expansion for the scattering matrix, coupled with computed values, clearly demonstrated that relaxation to the next lower level dominates all other transitional paths. A simple formula was derived that estimates an upper bound for the relative strengths of these paths.

KNOWLEDGE-BASED GROUPWARE FOR GEOGRAPHICALLY DISTRIBUTED COLLABORATIVE COMPUTING ENVIRONMENTS

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ABSTRACT

Feasibility analysis of the knowledge-based group decision support solutions based on groupware and collaborative computing technologies is the major subject of this study. Research on extending of current Group Research Laboratory for Logistics (GRLL) facilities in computer support of problem-solving groups into geographically distributed problem-solving environments is required for different group support projects at the Armstrong Lab Analysis of initial business requirements is based on the GRLL experience with different problem-solving sessions at the electronic meeting room. It is complemented by the results of information requirements analysis for the Quality Air Force Program at the Aeronautical Systems Center. Different business process engineering, process assessment, and quality management activities are considered subject to face-to-face, distributed asynchronous, and distributed synchronous forms of collaboration. Technology of collaborative computing is essentially capable to provide required distributed extension of an electronic meeting room environment by means of peer -to-peer and multiperson wide-area multimedia networking. It implies some specific communication constraints to be satisfied, but feasible solutions are already on the market, and their choice is a matter of test experiments. Another critical issue is an architecture of group decision support tools, subject to the changes in team communication. The proposed structure of application layer agents is based on evaluation of coordination support agents, learning features, and the specifics of distributed knowledge base management and models integration. Case-based reasoning technology is used to support the group coordinator to monitor consensus making on distributed network, as well as to incorporate an individual knowledge into the group memory representation. Results also include the sample of agent-facilitator for hypermedia-based asynchronous collaboration, and the plan of experiments with desktop videoconferencing environment.

CONCEPTUAL STUDY OF THE MARAUDER OPERATION IN THE NEUTRON PRODUCTION MODE

by

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A b s t r a c t

The potential use of the MARAUDER facility, operational at SHIVA-STAR capacitor bank, for D-D and D-T neutron production were studied. Three schemes of neutron production were considered: (a) compact toroid (CT) collision against a solid target; (b) use of the CT as opening switch for the plasma focus action; and (c) MARAUDER operation in the plasma focus mode (without CT formation). All three schemes are promising a possibility of producing E(18)/shot of 14 MeV neutrons (for W=9 MJ). This is the yield necessary for nuclear explosion simulation and advanced material technology. The above estimates were done keeping in mind the use of existing hardware at the PL/WSP. This opens an exciting opportunity to challenge the Russian projects presently on an advanced level of execution.

N o t e : This report is a summary of concepts that the author developed during his 12-weeks stay at Phillips Laboratory. Many elements presented here were already "circulating" in the High Energy Plasma Division PL. Other concepts were developed following long hours of discussion with HEPD/PL colleagues, to whom the author is truly grateful. Special thanks are extended to Dr. James H. Degnan and Dr. Gerry Kiuttu for the introduction to MARAUDER physics and technology, Dr. Robert Peterkin and Dr.Norman F. Roderick for the explanation of CT-acceleration and target collision phenomena and to Maj. Allen Chesley for the computer visualization of PF/MARAUDER operation principles in the neutron mode.

Quantitation of Dissolved O_2 in Aviation Fuels by Fluorescence Lifetime Quenching.

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Abstract

A new method for quantitation of dissolved molecular oxygen in aviation fuels is described. The approach is based on determination of the fluorescence lifetime of pyrene doped in the fuel at the ppm level. Oxygen quenches the pyrene fluorescence lifetime permitting the generation of linear calibration curves based on Stern-Volmer kinetics. The method is rapid, sensitive, less expensive than current methods, insensitive to thermal stressing of the fuel, and capable of on-line analysis and spatial profiling of oxygen concentration in fuel lines. Application to flowing fuel oxygen consumption tests demonstrates the technique.

AN EMPIRICAL EXAMINATION OF THE EFFECT OF SECOND-ORDER SAMPLING ERROR ON ASVAB-TRAINING PROFICIENCY VALIDITY ESTIMATES

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Abstract

Within the context of estimating the criterion-related validity of the ASVAB Arithmetic Reasoning subtest and Mechanical Composite for predicting final grades in Air Force technical training schools, this study examined the influence of small sets of studies from the research domain of 191 apprentice (level 3) technical training schools on estimates of the mean and variance of validity coefficients in the research domain. More specifically, the effect of randomly sampling three different numbers of studies per meta-analysis (i.e., 5, 10, and 15) from the research domain on the estimates of the mean and variance of validity coefficients in the research domain was examined for two types of meta-analyses: (a) bare-bones meat-analyses where first-order sampling error was the only statistical artifact considered, and (b) meta-analyses involving corrections for sample-based artifacts (i.e., sample size, range restriction, and predictor reliability). In general, there are three primary conclusions from this study: (a) for both types of meta-analyses, when one desires to generalize to all studies in this research domain, small numbers of studies (in particular, samples of 15 studies) may provide adequate estimates of the mean and variance of validity coefficients, (b) when subjects and studies from relevant subpopulations (e.g., career fields) in the research domain are not sampled in proportion to their representation in the domain, the estimates of the mean of the validity coefficients may not closely approximate the mean of the validities in the research domain, and (c) given the possibility of overstating the minimum level of validity from a small number of studies in a meta-analysis, a suggestion would be to employ Ashworth, Osburn, Callender, and Boyle's (1992) for evaluating the robustness of meta-analytic findings.

DEVELOPMENT OF AN ACTIVE DYNAMOMETER SYSTEM

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Abstract

In this paper, we describe the experimental development of a prototype computer controlled dynamometer system (i.e., an active load) which can produce arbitrary desired load torques for machines and drives testing. The dynamometer system consists of an arbitrary motor under test which is rigidly coupled to a load dynamometer motor. An advanced motion controller is then designed for the dynamometer motor such that it presents desired load dynamics to the motor under test. The control algorithm is implemented using a digital signal processor based data acquisition and control system. The nonlinear control approach is based on an integrator backstepping technique and facilitates the application of a broad class of high-performance dynamometer motion controllers.

A STUDY OF THE APPLICABILITY OF FRACTALS AND KINETIC EQUATIONS TO ELECTROMIGRATION AND THERMALLY INDUCED HILLOCK AND VOID EVOLUTION

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Joseph Chaiken*, Associate Professor
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Abstract

The growth of hillocks and voids in metal films was studied. The applicability of a model involving fractals and kinetic equations was examined on the basis of whether there is independent justification for using scaling arguments in the model and for whether there is reason to connect the evolution of hillocks with that of voids. Hillocks and voids were found to be self-similar across about three orders of magnitude of variation in spatial scale with the same fractal dimension. Voids and hillocks were found to have the same fractal dimension whether studied using atomic force microscopy (AFM) or scanning electron microscopy (SEM). The parameters obtained from these fractal analyses demonstrate quantitative internal consistency with an earlier time dependent study of thermal annealing effects on hillock distributions. Remarkably, area-perimeter data obtained from either a long-time study of a single void or a spatial everage of a large number of different voids both yield quantitatively identical results.

Least-Squares Finite Element Methods for Incompressible Flow with Zero Residual for Mass Conservative Law

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Abstract

This report contains two parts. In part one, a numerical method for least-squares finite element method (LSFEM) which enforces mass conservation, and the corresponding mathematical analysis is presented. In part two, a LSFEM for Stokes flows with multiple fluids is developed.

During the last few years, people have tried to find a new method for simulating incompressible flow without being subjected to the inf-sup condition, to which end LSFEM has been developed. In this work it was found that in simulating the flow about a cylinder moving along the axis of a narrow channel using the LSFEM in the vorticity-velocity-pressure form, the mass conservation law was not satisfied everywhere in the domain. During the Summer of 1994, Captain John Nelson and I developed a restricted LSFEM using the Lagrange multiplier which insure that the mass is conserved everywhere.

In the second part, a LSFEM is developed to simulate flows involving multiple fluids. For multiple fluid flows, not only the body equations governing the flow, but also conditions of continuity of velocity and stress across the interface separating the two fluids must be satisfied. Unlike the Galerkin method, the conditions for continuity of stress must be explicitly added to the LSFEM. In the mutiple fluid LSFEM, the condition for continuity of stress are viewed as restrictions and are added to the standard LSFEM in the stress-velocity-pressure form by using Lagrange multiplers. We present the results of using this method for a test case simulation.

This work was performed with Captain John J. Nelson in the Wright Laboratory WP AFB, 1994

ON TESTING THE EQUALITY OF COVARIANCE MATRICES UNDER SINGULARITY

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Abstract

This report considers the problem of statistically testing the equality of two covariance matrices from complex multivariate normal distributions. The underlying distribution is assumed to be singular in the sense that one of the two sample covariance matrices has rank one and the other is of full rank. A test procedure is proposed and its distributions under null and alternative hypotheses are derived. Two interesting properties of the test procedure, invariance and monotonicity properties of the power function are studied for a general setting, and then apply to the special case studied in this project. The test procedure is also shown to be equivalent to several other well-known test procedures which were previously studied only for the regular case, that is, when both sample covariance matrices are of full rank. Some suggestions for further research are given in the last two sections of this report.

A STUDY OF THE KINEMATICS, DYNAMICS AND CONTROL ALGORITHMS
FOR A CENTRIFUGE SIMULATOR

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Abstract

A preliminary study of the kinematics, dynamics and control algorithms for a centrifuge simulator is conducted in this research. The centrifuge is modeled as a three joint manipulator. It is shown that the centrifuge simulator is an underactuated mechanism where the number of joints is less than the number of degrees of freedom needed to be controlled at the end effector (or the seat in the case of a centrifuge). Algorithms for solving the joint velocity and joint acceleration are quite different from those used in conventional manipulators. Here, we study the feasibility of various approaches for solving the joint velocity and joint acceleration with the prescribed trajectory of the end effector (of the pilot). In order to command the end effector (or the seat in the centrifuge) to follow the prescribed trajectory, various optimal control algorithms are proposed for the motion control of the centrifuge.

DETERMINATION OF THE INTERFACIAL HEAT TRANSFER COEFFICIENT IN A REGENERATOR OF A CRYOCOOLER

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Abstract

Correlation equations for the interfacial heat transfer coefficient, the effective axial thermal conductivity, and the pressure drop of an oscillating and reversing flow through a stack of screens are needed for an optimum design of a regenerator in a cryocooler. At the present time, the design of these regenerators is based on the correlation equations obtained for steady flow in a compact heat exchanger. In this report, relevant literature on the transport processes occurring in the regenerator, heat exchangers, and the pulse tube of an orifice pulse-tube refrigerator is reviewed. Experimental work initiated at the Phillips Laboratory in cooperation with the University of Hawaii for the determination of the correlation equations of the heat transfer and fluid flow characteristics in a regenerator under periodically reversing flow conditions is discussed. A method for the analysis of the experimental data is described.

ON CLASSIFICATION OF MULTISPECTRAL INFRARED IMAGE DATA

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ABSTRACT

In this work we analyze a detector on the basis of a model whereupon each signal component consists of the radiant thermal energy contributed by the emissivity and the blackbody radiation reference (BBRR) of either the small low-observation target or the intense, highly structured background. A low-order power series is employed to approximate the BBRR. A sufficient statistic, when the underlying sensor noise and spectral emissivities are normally distributed, is derived. It is shown that the new detector is effective in enhancing the target and suppressing cluttered background on a pixel-by-pixel basis. It is also shown that under more regular conditions, the new detector represents other classes of detectors, including the constant emissivity detector and the maximum *a posteriori* type detector. This suggests that the new class of detectors performs at least as well as other classes of detectors and yields better performance when some restrictive conditions are relaxed. Numerical computations demonstrate the superior performance of the proposed detector.

A NEW SUPERPOSITION

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Abstract

A channel's fading can be modeled as the product of a slowly varying component and the transmitted signal. An amplitude-modulated signal is also represented by a product of a carrier signal and envelope function. In these systems homomorphic signal processing for multiplication can be used to give impressive results. Superposition is a generalized principle of homomorphic signal processing.

The logarithmic function will transform a system modeled on a product to a conventional linear system that will yield to a classical attack. It is shown here that the logarithm, as a generalized superposition, will also transform a conventional linear system into another linear system and therefore nothing need be known about the original system before applying a logarithmic transformation.

DETECTION PERFORMANCE OF OVER RESOLVED TARGETS WITH NON-UNIFORM ENERGY DISTRIBUTION IN THE RANGE CELLS

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Abstract

Many formula involved in computation of radar detection performance, such as incomplete Toronto functions and modified bessel functions, have very bad numerical behaviors. This fact leads to errors of the results. Also, in the calculation of radar detection performance, it is generally assumed that the energy is uniformly distributed over the resolution cells. However, in practice the cells may have different energy. In these cases, modifications are necessary in computing the detection performance.

In this paper, we developed numerical methods to overcome the numerical difficulties and thus obtained much more accurate results. Also, we developed a realistic model of energy distribution, and found that the probability of detection generally tends to increase when the energy is not uniformly distributed. The phenomena are interpreted by the shape of the curves corresponding to uniformly-distributed energy.

SYNTHESIS OF NOVEL SECOND AND THIRD ORDER NONLINEAR OPTICAL MATERIALS

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ABSTRACT

Polyparaphenylene based systems have interesting electrooptical properties but major solubility problems and hence require side chains to assist in subsequent characterization or use. In this work, we have developed both second and third order nonlinear optical materials based on incorporating fluorene FL groups into the backbone of the desired materials along with paraphenyl groups. Here the bridging carbon was alkylated to ensure the solubility of the resulting materials in common organic solvents. The symmetric A-FL-A type systems were designed to have novel third order properties, whereas the non-symmetrically substituted systems A-FL-B (in this case A being a thiophene group and B being a pyridine group) have interesting second order properties.

THE SENSOR MANAGER PUZZLE

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Abstract

The task of a sensor manager is to improve the performance of the individual avionics sensors by coordinating their activities based on the sensor manager's best estimate of the future. This paper reviews planning and scheduling literature to identify developments that might apply to the design of a sensor manager. Applications examined primarily come from the planning and scheduling of manufacturing plants. An interpretation of the sensor manager as a manufacturing plant is included. Most of the reviewed work is from the artificial intelligence community.

A RESEARCH PLAN FOR EVALUATING WAVE GUN AS A LOW-LOADING MODEL LAUNCHER FOR HIGH SPEED AEROBALLISTIC TESTS

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and

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Abstract

A specialized light gas gun firing cycle, developed by Thomas Dahm of Astron Research and Engineering and named by him the Wave Gun, is investigated as a candidate for launching models in a ballistic range to high speed with relatively low model loading. The Wave Gun firing cycle features a very light piston which oscillates during the shot and produces a series of shock impulses on the model. A light gas gun interior ballistics code that simulates the Wave Gun firing cycle was used to evaluate launcher performance for a matrix of launcher geometric and launch parameters. A Wave Gun test facility, designed and constructed by Astron, was used to provide data with which to verify the fidelity of the simulation code. Pressure histories were recorded in the combustion chamber, the pump tube exit, the nozzle exit and at three axial stations along the launch tube. In addition the first-pass piston velocity and the model muzzle velocity were determined. Two test shots were fired. During the second shot a nozzle structural failure occurred and further testing was suspended pending fabrication of a new nozzle. The data acquired from the tests were not sufficient to verify the numerical model. However, the tests did provide experience in operation of the gun and data acquisition, and they provided insight into the status of the numerical model and the direction that future testing should take. A plan is presented for numerical and experimental studies to identify parameter sets that produce high velocity with moderate model loading. Initial testing and analysis will be devoted to validation of the gun cycle simulation code. Then parametric studies, supported by appropriate tests, will be carried out. Six parameters identified for consideration in these studies are propellant type and weight, helium charge pressure, pump tube volume, piston start pressure and model start pressure. Launch tube and model configurations will be held constant.

CONCURRENT COMPUTATION OF ABERRATION COEFFICIENTS

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Abstract

The method of Phase Diversity is useful to measure the aberrations caused by distortions by atmosphere and other media. Two images are taken: one at a focused position and the other at a defocused position. By minimizing the Gonsalves metric, the Zernike aberration coefficients are estimated and thus the aberration that produced the distortion in the original image is obtained. Being a nonlinear optimization technique involving several variables, the method is very compute intensive. We introduce a method using nonlinear optimization involving only a single variable to independently, hence potentially concurrently, evaluate the different Zernike coefficients. The method of independent evaluation of Zernike coefficients can be further speeded up by using parallel processing and neural network techniques. Our method works both for point source objects as well as extended objects.

THE BENCHMARK DOSE APPROACH FOR HEALTH RISK ASSESSMENT: TCE

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ABSTRACT

The Benchmark dose approach in health risk assessment is critically reviewed for noncancer endpoints. The algorithm for obtaining the benchmark dose for both quantal and continuous data is developed using SIMUSOLV software package prepared by the DOW Chemical company. The mathematical models used in modeling the dose-response relationship, the statistical methods used in testing the trends, goodness-of-fit and obtaining the upper confidence limits are presented. The benchmark dose for trichloroethylene (TCE) for reproductive endpoints data calculated using the developed algorithm is found to be 246 mg/kg/day for oral route and 57 ppm for inhalation route. Benchmark doses can be used in getting the reference doses by applying the uncertainty factors for setting up the regulatory standards for workers exposure to TCE or for environmental management purposes. Additional research is recommended using an improved algorithm that could substantially change the benchmark dose values calculated here.

LONGITUDINAL WAVES IN FLUID LOADED COMPOSITE FIBERS AND FIBERS EMBEDDED IN A SOLID MATRIX

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Abstract

The theoretical model for longitudinal waves traveling in a transversely isotropic fiber in a transversely isotropic matrix has been developed. The fiber first is studied in a fluid and then in the solid matrix. Dispersion curves for various modes of wave propagation in fiber, a hollow tunnel and then, the fiber in a matrix, have been obtained. The governing equations for a damage zone around the fiber have been derived. The damage is modelled as a thin layer of material as well as a massless spring.

ANALYSIS TO DETERMINE THE QUALITY FACTOR OF A COMPLEX CAVITY

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Abstract

The low frequency, preliminary analysis of a simplified model of a space craft sensor has been accomplished using CARLOS-3D™ (Code for Analysis of Radiators on Lossy Surfaces), a general purpose computer code using the Method of Moments (MoM.) Resonances of a cavity region have been identified by determining the cavity quality factor (Q) as a function of frequency. The Q is proportional to the total energy stored in the cavity and inversely proportional to the power lost from the cavity due to lossy materials and apertures. Even though this measure does not give an exact value for power density at a specific point in the system, it does give an indication of the representative power levels one will find in a similar system. An analysis approach for the high frequency range includes using GEMACS (General Electromagnetic Model for the Analysis of Complex Systems) which incorporates the geometrical theory of diffraction, MoM, and the finite difference method for multiple region problems. A comparison of the two methods (CARLOS-3D™ and GEMACS) at an intermediate frequency (~3 GHz) is proposed.

NOISE AS A STRESSOR: AN ASSESSMENT OF PHYSIOLOGICAL PARAMETERS AND RADIOTELEMETRY EQUIPMENT AVAILABLE TO STUDY ITS EFFECTS ON ANIMALS

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Abstract

Noise as a stressor to animals is discussed with respect to the physiological parameters that can indicate that an animal is stressed. Known currently available radiotelemetry systems that can monitor some of these parameters are given and their sources are indicated. Data that can be reliably derived from parameters obtained by currently available radiotelemetry systems are presented. Possible pathology due to long-term stress as well as information for conducting animal studies, performing radiotelemetry implant surgery and anesthesia, and the potential complications of implant surgery are presented. Finally, recommendations for future study of noise as a stressor to animals are made.

UNIDIRECTIONAL RING LASERS AND LASER GYROS WITH MULTIPLE QUANTUM WELL GAIN MEDIA

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ABSTRACT

Very thin (compared to the wavelength) gain and dielectric layers have similar reflection properties, except for a phase factor of $\pi/2$. This particular difference makes it possible to design non-reciprocal elements, having a zero reflectivity from one direction, and a finite reflectivity from the other direction. This non-reciprocity is exploited to design unidirectional lasers.

DISCRETE WAVELET TRANSFORMS FOR COMMUNICATION SIGNAL DETECTION

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Abstract

This report describes the possible use of wavelet transforms for detection of communication signals. An initial study was performed to assess the possible use of the discrete wavelet transform for detection of LPI spread-spectrum communication signals. A set of MATLAB M-files were developed for this purpose. They include a "fast wavelet transform" (FWT) and its inverse, as well as a number of graphical display routines which serve to present the wavelet transform in a number of different formats, as well as to be used as a tutorial by someone who is unfamiliar with this area. The FWT is implemented in C code as a MEX file, and executes very quickly on the Sparc 10 workstation. Timing tests show it to be faster than the MATLAB implementation of the FFT for vector lengths greater than 2048. (Note that the FWT is a k N algorithm, while the FFT is an N log N algorithm.) The results of this study indicate that the discrete wavelet transform can potentially be effective in this application.

ELECTRO-OPTIC CHARACTERIZATION
OF POLED-POLYMER FILMS

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Abstract

We investigated methods for measuring the electro-optic activity of poled-polymer films. In particular, we scrutinized the well-known reflection technique of Teng and Man[1] and corrected the expressions for the electro-optic coefficient as determined by that method. We show that the original expressions in ref. [1] overestimate the effective coefficient r_{33} by a factor of at least 1.32. Because of limitations in the technique of Teng and Man[1], we pursued independent electro-optic activity measurements using an interferometer. To achieve this goal, we developed a computer algorithm that utilizes a controllable, motorized Babinet-Soleil compensator in one arm of an interferometer to stabilize the fringe pattern. With a Michelson interferometer we measured the r_{13} electro-optic coefficient as well as a resonant piezoelectric and electrostrictive effect. We show that in general the ratio $r_{33}/r_{13} \neq 3$, and we discuss how the piezoelectric effect might pollute electro-optic measurements made with the reflection technique.

EXPERIMENTAL MEASUREMENT OF NONLIEAR EFFECTS IN FIBERS BASED ON DEGENERATE TWO-WAVE INTERACTIONS.

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Abstract

We describe an experimental procedure to characterize optical nonlinearity and dynamic effects in fibers. The method is based on degenerate two wave mixing. In this method intensity dependent optical nonlinearity, such as the nonlinear refractive index, is induced by a high intensity laser beam in the fiber. The nonlinear effect is measured by probing with a weak probe signal time synchronize and having the same frequency as the pump. Effects such as pulse broadening and wavelength shift are also measured.

FUNDAMENTAL STUDIES ON THE SOLUTION AND ADSORPTION PROPERTIES OF BLOCK COPOLYMERS

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Abstract

Fundamental solution and adsorption properties of block copolymers have been investigated using Low Angle Laser Light Scattering (LALLS), Atomic Force Microscopy (AFM), and Ellipsometry (ELLI). Additionally, the solution properties of poly(vinyl caprolactam), a water soluable polymer used to inhibite hydrate growth in oil and gas pipelines, have been studied.

We report the first experimental results on the scaling characteristics of brush-forming middle-adsorbing triblocks. The triblocks used consist of relatively short poly(ethylene oxide) (PEO) middle blocks and much longer polystyrene (PS) end blocks. Adsorption takes place onto a well characterized silicon dioxide surface from toluene and ellipsometry is used to determine the adsorbed amount. We find that the surface density, σ, for each of the copolymers (both those in the symmetric and asymmetric regimes) scales according to the simple relationships proposed in the theory of Marques and Joanny (i.e. in the symmetric to moderately symmetric regime, $\sigma \propto N_A^{-1}$, where N_A is the number of segments in the adsorbing PEO block and in the highly asymmetric regime, $\sigma \propto \beta^{-2}$, where β is the ratio of the size of the non-adsorbing block to the size of the adsorbing block).

The scaling behavior of the radius of gyration of polystyrene homopolymers in toluene has been determined; it was found that R_g (Å) = 1.76 $N_{ps}^{0.597}$ for polymers with a molecular weight greater than 100,000 g/mol. For lower molecular weight polystyrene samples, we find R_g (Å) = 7.16 $N_{ps}^{0.401}$. Finally, for poly(vinyl caprolactam) homopolymers in water, it was found that R_g (Å) = 6.30 $N_{pv\text{-}cap}^{0.56}$. Based on this information it is possible to derive an engineering correlation for the overlap concentration, we find c^* (mg / ml) = 6315 $MW_{pv\text{-}cap}^{-0.68}$ where $MW_{pv\text{-}cap}$ is the polymer molecular weight.

Effects of Temperature on various Hematological Parameters

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ABSTRACT

Using human blood samples, we have determined the effects of temperature on the following hematological parameters: Erythrocyte Sedimentation Rate (ESR), Mean Red Cell Volumes (MCV), Mean Platelet Volumes (MPV) and the sodium/potassium ratio in the plasma of heat-treated whole blood. As described in previous Reports, ESR data obtained over the range from about 30 ^{o}C and up to approx. 52 ^{o}C show distinct, abrupt and frequently dramatic changes near 45 ^{o}C and somehat similar changes are observed at this temperature in the measured volume properties (MCV and MPV) and ion-distribution data. The temperature range from 44 ^{o} to 46 ^{o}C is known to be a critical temperature range for all mammals and birds and is indeed the upper thermal limit for such organisms. As stressed in our earlier Reports, the dramatic effects near 45 ^{o}C undoubtedly reflect the transition at the third vicinal water thermal transition temperature ($T_{k=3}$) which is known to affect a large number of parameters of the cell-associated water [see papers by Drost-Hansen et al.]. Some measurments of the same parameters have also been made at lower temperatures, for instance from 8 ^{o} to 25 ^{o}C and from 20 ^{o} to 37 ^{o}C. Some indications of anomalies near 15 ^{o} and 30 ^{o}C have been seen (corresponding to the lower, critical thermal transition temperatures for vicinal water, $T_{k=1}$ and $T_{k=2}$) but the anomalies at these temperatures are far less pronounced than the 45 ^{o} C anomaly. To insure the best resolution practical, measurements have been made over the different temperature intervals at increments of 0.6 ^{o} to 0.9 ^{o}C using our Temperature Gradient Incubator (TGI or "Polythermostat") which allows for simultaneous measurements at 30 different, constant temperatures. Earlier we have proposed that the distinct changes near 45 ^{o}C ($T_{k=3}$) may play an important role in hyperthermia treatment of malignancies. While the findings in the current study do not prove this supposition, the data are consistent with this proposal: dramatic changes appear to take place at this critical temperature in such parameters as the ESR (probably reflecting reduced Red Cell-aggregation and/or rheological changes in the blood, likely related to vicinal hydration changes of the proteins present), and/or intracellular ion or solvent activities, and possibly changes in the stability of critical membrane-associated proteins or enzyme activities. Such changes may indeed preferentially affect the thermal stability of malignant cells compared to normal cells if the relative abundance of vicinal water in malignant cells differs from that of normal cells. The latter proposition is likely true as it is well-known that malignant cells have notably elevated water contents compared to healthy cells. The excess water of the malignant cells more closely resembles "bulk water" (solvent) than vicinal water.

MEMORY FOR SPATIAL POSITION AND TEMPORAL OCCURRENCE OF DISPLAYED OBJECTS

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Abstract

Two experiments were conducted to assess memory for spatial and temporal occurrence attributes of visually displayed stimuli. A cueing procedure was used in which the subject was told whether to respond to spatial position or temporal occurrence on a trial by trial basis. The experiments examined whether the ability to recall the time of occurrence or spatial position of previously seen objects was a function of the relation between time and place of occurrence of the to-be-remembered items and whether it was a function of the time at which a cue was presented to indicate whether temporal or spatial occurrence was to be recalled. The results support the hypothesis that neither spatial location nor temporal occurrence can be completely ignored even when task demands are such that performance suffers from attendance to both attributes. Surprisingly, subjects were unable to ignore the occurrence attribute that was irrelevant on a given trial even when informed about which attribute to attend to before the presentation of the stimuli. Implications for the design of displays and for theories of memory representation are discussed.

INFLUENCE OF MODEL COMPLEXITY AND AEROELASTIC CONSTRAINTS ON THE MULTIDISCIPLINARY OPTIMIZATION OF FLIGHT VEHICLE STRUCTURES

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Abstract

This investigation focused upon the structural weight optimized design of two finite element models of a fighter-type wing of low aspect ratio using ASTROS. The optimal redesign of a fighter wing with the wing structure represented by a coarse and a complex finite element model is obtained with constraints imposed on strength, control reversal, and flutter using both subsonic and supersonic aerodynamic theories. The results from the two wings are comparable for flutter analysis; however, the results differ somewhat for control reversal. The reasons for this difference are investigated. Further study of both wings using different design variable schemes is also conducted.

FUEL IDENTIFICATION BY NEURAL NETWORK ANALYSIS OF GAS CHROMATOGRAPHY DATA

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Abstract

Neural network methods including back-propagation have been successfully applied to the analysis of jet fuel gas chromatography data. The gas chromatographic profiles of aviation fuels have been used to train artificial neural networks to correctly classify fuels in two different data sets. Attention was paid to minimizing the number of features and optimizing the network architecture required to accomplish classification.

REGIONAL ARTERIAL COMPLIANCE AND RESISTANCE CHANGES FOR TRANSIENT +Gz PROFILES

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ABSTRACT

The primary aim of this research is to determine regional variations in peripheral resistance, blood volume and arterial compliance caused by transient +Gz loads. A model previously used to analyze systemic arterial compliance and total peripheral resistance is extended to allow similar calculations for the head, lungs and body as well as shifts in blood volume between these regions. Gravitational loss of consciousness (G-LOC) is a direct result of a prolonged blood volume shift from the head to the body and the new model allows a study of the relationship between this shift and regional changes in resistance and compliance on a beat to beat basis. Practical surgical limitations require the development of a new transducer for measuring pressure and flow in the pulmonary artery and the aorta before the method can be implemented. Preliminary work with a modified transit time ultrasonic transducer shows promise as a solution to this problem.

A METHODOLOGY FOR AFFORDABILITY IN THE DESIGN PROCESS

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Abstract

Performance has always been the driver of weapon systems design. Today, with dwindling financial resources, the consideration of life-cycle cost has become another major driver that profoundly affects the design. In order to access affordability, tools and techniques need to be developed. It is well known that over 80% of the cost of a design is committed at the conceptual level, therefore, in order to have the greatest leverage, affordability has to be considered before the form of the design is firmed up. Once the concept is established, tools such as Cognition's cost modeler and Boothroyd Dewhurst's DFA can predict to a certain level the cost of manufacture and assembly. Other tools such as Taguchi's and the Six Sigma approach allow producibility to be quantified. No such tools exist at the conceptual stage. This report summarizes the published work that deals with costing and producibility tools that apply to different stages of the design process. It then proposes a methodology to deal with affordability early at the conceptual stage. The methodology is based on the use of the QFD house of quality and the identification of the non-linear engineering characteristics that affect the performance drivers. Such a tool aims at identifying where a design lies on the performance - affordability or performance - cost curves to help in prioritizing research needs. The report concludes with recommendations to the Air Force aimed at dealing with the affordability issue in educational institutions, industry and the government.

TOWARDS THE COMPUTATIONAL MODELING OF POSTSTALL GAS TURBINE COMBUSTOR DYNAMICS

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Abstract

This report summarizes an eight week investigation aimed at providing suggestions for making improvements to a dynamic engine code called ATEC (Aerodynamic Turbine Engine Code) in the area of modeling the transient behavior of gas turbine combustors during poststall dynamic events. The paper will consist of a brief literature review of computational modeling of gas turbine combustion in general, followed by a discussion of some of the key physical issues dealing with poststall combustor dynamics as well as previous efforts directed towards modeling this phenomena specifically detailing a Pratt & Whitney developed transient combustion code called TRANSI. A summary of the current status of the ATEC project, with particular emphasis on how the combustor is modeled, will be provided. Then a suggested course of action is proposed to improve the combustor model. Preliminary developments on a transient combustion computer code are discussed and future improvements and directions for development and application are outlined.

COMPUTER MODELING OF ELECTROLYTES FOR BATTERY APPLICATIONS

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Abstract

An objective of this effort was to evaluate high-end software packages for computational chemistry for their ability to model salt–electrolyte systems in a variety of circumstances. The goal was to provide an understanding of the molecular basis for efficient electrolyte systems and to develop a methodology for follow-up studies. Of initial interest was the simulation of salt dissolution and electrolyte association.

The program selected for use in this study was Cerius^2 (Molecular Simulations). The UNIVERSAL force field (UFF) combined with the Charge Equilibration (QEq) method was evaluated for its reliability in predicting atomic charges and geometric parameters for a range of structures. These include several ether structures such as tetrahydrofuran, model compounds for the polymeric electrolyte poly(ethylene oxide) (PEO), crown ethers, PEO, and the anions of several lithium salts. Comparison of UFF/QEq results was made with experimental data and predictions from ab initio and semiempirical molecular orbital methods where available. In general, UFF/QEq gave good results, comparable to ab initio values in many cases; however, there appears to be a systematic problem with the UFF or QEq parameterization for sulfur-containing compounds, such as tetrahydrothiophene (THS) and triflate anions. Recommendations for future studies are given.

Within the limitations of the UFF/QEq method cited above, the molecular-dynamics simulation capability of Cerius^2 was used to investigate the association of Li cations in 1,2-dimethoxyethane (DME) — a model compound for PEO. In the first approach, a single Li cation and a molecule of DME were minimized (UFF/QEq) in a nonperiodic box. The resulting structure showed the association of the cation with one oxygen of DME which remained in its low energy conformation. Next, constant volume and energy (NVE) anneal dynamics was used to investigate other minimum energy structures. The result was a change in the DME conformation to accomodate the association of both oxygen atoms with the cation. In a higher level simulation, 4 Li cations were added to a (nonperiodic) solvent box containing 64 DME molecules at 300 K. This system was then minimized (UFF without QEq). The Li cations were well dispersed within the box but no specific associations were identified. Finally, quench dynamics was used. All cations were associated with at least one oxygen. Two cations were each associated with two oxygens from different DME molecules.

Scanning Image Algebra Networks for Vehicle Identification

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ABSTRACT

Digital image analysis techniques for identifying vehicles in complex scenes were studied. Neural networks that learn image algebra operations for feature extraction and classification simultaneously were applied to the problems of detecting tanks in Infrared (IR) imagery and Chevrolet Blazers in visible imagery. Results on the tanks reconfirmed earlier results with different networks that show networks are capable of generalizing from a much smaller set of examples than matched filters. The Blazers were in parking lots filled with a variety of vehicles. Several test Blazers were in the lot at a variety of ranges, aspects, and depression angles. Empirical results show that the image algebra networks can store a variety of representations of Blazers, including range, aspect and plane rotation angles. In addition, the networks exhibited the capability of generalizing to Blazers with different paint and options in some cases and could detect partially occluded Blazers. Further research is required to suppress network output on complex backgrounds.

LASER RADAR
PERFORMANCE MODELING AND ANALYSIS
WITH EMPHASIS ON BMDO'S ASTP PROGRAM

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Abstract

This report presents the highlights of the results of Dr. Gatt's AFOSR Summer Faculty Research Program. Particular emphasis is given to those activities which related to performance modeling of laser radar systems. Two specific ladar systems were analyzed. The first was, a solid-state coherent detection ladar system, for BMDO's Advanced Sensor Technology Program (ASTP). The second was a direct detection angle-angle-imaging ladar currently in field use at Eglin AFB (WL/MNGS). Results of numerical analyses of the performance models for these two systems are provided in this report.

In addition to these analyses, a brief description of the other major tasks conducted by Dr. Gatt is also given in this report. These tasks included, (1) the design of a laboratory coherent laser radar test bed, (2) the design of an AFGL FASCODE interface program for a personal computer, and (3) teaching of a laser radar short course which compared and contrasted direct detection ladars with coherent detection ladars.

LASER INDUCED BUBBLE FORMATION IN THE RETINA

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Abstract

The immediate thermodynamic effects of absorption of a laser pulse in the retina were theoretically investigated. The absorption occurs in a retinal pigment epithelium modeled as an aqueous environment with absorption occurring at small spherical sites with absorption coefficients representative of melanosomes. For laser pulse durations of less than 10^{-6} seconds, heat conduction is negligible during energy deposition and the resulting large energy density in the melanosome will cause vaporization of the surrounding medium. We develop expressions for calculating the size of the bubbles produced as a function of laser characteristics and melanosome properties. We also show that for pulse durations between 10^{-6} to 10^{-9} seconds, bubble formation will occur for laser fluences that are smaller than those required to cause Arrhenius type thermal damage. Therefore bubble formation is likely to be the source of threshold damage to the retina for laser pulse durations in this regime.

AN INVESTIGATION OF HYDROXYLAMMONIUM DINITRAMIDE: SYNTHESIS, STABILITY, AND COMPATIBILITY

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Abstract

Hydroxylammonium dinitramide (HADN) was prepared from ammonium dinitramide (ADN) by means of an ion exchange reaction to produce dinitramidic acid followed by an acid-base reaction with hydroxylamine yielding HADN. The procedure is, effectively, a one step process. It has several advantages over previously used methods. The stability of the compound and its compatibility with various substances were also examined.

RELATION BETWEEN DETECTION AND INTELLIGIBILITY IN FREE-FIELD MASKING

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and
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ABSTRACT

Experimental and theoretical studies are investigating spatial hearing by measuring signal detectability and speech intelligibility in the free field. The research emphasizes the impact of interfering auditory stimulation on spatial hearing performance. Studies that examine the detectibility of signals as a function of their spatial relation to a masker will be used to predict the intelligibility of masked speech. The frequency-dependent role of specific acoustic cues for mediating detection and recognition performance will be addressed. This research will have direct relevance for basic science by delineating the acoustic cues and potential mechanisms underlying spatial hearing phenomena. The results will also have relevance to the design of auditory displays and virtual realities by specifying how the spatial distribution of sounds influences the ability of listeners to detect and understand auditory signals.

ANALYSIS OF LASER DOPPLER VELOCIMETRY DATA

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ABSTRACT

The work accomplished at Wright Laboratory this past summer can be subdivided into three major tasks. The first task was the development of a computer based data smoothing algorithm so that measured profiles of turbulence statistics (i.e. mean, Reynolds stresses, and turbulent triple products) can be smoothed automatically. Specifically, laser Doppler velocimeter (LDV) measurements were smoothed in this work, however, the algorithm is general and thus could be applied to smooth any experimentally obtained profiles. The second task involved the determination of the statistical uncertainty of the measured mean velocities and turbulent normal stresses. Lastly, a series of computer programs which smooth, numerically differentiate and plot LDV measurements made in the flow field surrounding an integrated fuel injector (IFI) were developed to help aide in the analysis of this data. In addition, a Wright Laboratory senior engineer was trained well enough to use and modify this software as part of this effort.

Issues Involved in Developing an Object-oriented System by Reengineering an Existing System

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Abstract

This report describes the issue and process of reengineering an existing system to develop an object-oriented model for the system. A systematic process of reengineering was applied to a subsystem of the Integrated Test Bed (ITB) facility. The ITB is used to support the development, testing, and evaluation of advanced avionics systems in the Avionics Directorate at Wright-Patterson Air Force Base. The subsystem being reengineered was the Guidance subsystem of the Operational Flight Program (OFP). The initial effort concentrated on the Terrain-Aided Flight Algorithm (TFA), or the Vertical Steering subsystem, a component of the Guidance subsystem. Then a bottom-up approach was used to derive an object model for the OFP. The objective of the reengineering task was to develop an object-oriented model for the current system . The system was initially implemented in JOVIAL and later in Ada. The first phase of the effort was to understand the existing system. This was accomplished by studying the related documents and code, and constructing design specifications for the existing system. Structure Charts were used to document the design of an earlier version of the system programmed in JOVIAL. Visibility Diagrams and notations similar to Object-Oriented Structured Design (OOSD) were used to document the design features of the current system implemented in Ada. The processes and corresponding data were grouped together to encapsulate them into objects/classes. The second phase was to develop an object-oriented model for the system. An object-oriented model was developed using the Object Modeling Technique. Some of the CASE tools used for this effort include Software Through Pictures™, Rational Rose™, and OMTool™. The report includes some of the experiences and lessons learned.

USING ELECTRONIC BRAINSTORMING TOOLS TO VISUALLY REPRESENT THE IDEAS OF OTHERS: A PROPOSAL FOR RESEARCH

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and

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The manner in which electronic brainstorming tools visually represent ideas may have important consequences for ideational performance. Existing information displays differ with respect to (a) the degree to which users control their own access to group information, (b) the visual representation of the information on the screen, and (c) the emphasis on group versus individual productivity. An explanation for the apparent lack of creativity of electronically assisted, interacting groups is presented based on the distinction between blind versus heuristical search processes. It is argued that, while existing brainstorming tools eliminate or reduce the detrimental effects of various situational factors, the cognitive algorithm typically used by brainstormers in interacting groups, the trailblazing heuristic, still prohibits the exploration of previously activated ideational categories. Three computer brainstorming studies, involving manipulations of motivational orientation and information display, are proposed in order to explore the effects of this heuristic search process on ideational performance. The results are expected to enhance the development of effective brainstorming software.

IMPROVED NUMERICAL MODELING OF GROUNDWATER FLOW AND TRANSPORT AT THE MADE-2 SITE

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Abstract

Public domain computer programs were used to attempt an improved model of the tritium plume observed during Macrodispersion Experiment 2 (MADE-2), a field scale natural gradient experiment conducted at Columbus Air Force Base, Mississippi. The program Geo-EAS used head and hydraulic conductivity data at a relatively small number of irregularly spaced test locations to estimate corresponding values at the more numerous nodes of a computational grid having 66 rows, 21 columns, and 9 layers. The finite difference program MODFLOW was used to simulate the flow of groundwater through a 330 m x 105 m computational domain. The recent BCF2 subroutine package, which permits rewetting of cells, allowed the vertical discretization to be more accurate than in previous studies. Solutions for the 468 day experiment were obtained using a Sun Sparcstation 2 for several choices of convergence and storage parameters. The simulations had small mass balance errors and were consistent with continuous head observations. The smallest storage coefficients gave the best agreement. One persistent feature of the predicted head field was a tendency for the head to decline toward the northwest. This suggests that the plume should bend toward the northwest, but the observations show a bend toward the northeast. This discrepancy is probably due to inaccurate head boundary conditions resulting from a lack of piezometers in the northern part of the computational domain. The flow model is about as accurate as the data permit.

Tritium plume simulations used the mixed Lagrangian-Eulerian finite difference program MT3D to solve the contaminant transport equation using the MODFLOW-predicted flow field. Thirteen runs were made using various advection algorithms and dispersivities, but none was successful. Numerical instabilities or grossly unrealistic predictions ended every run by simulation day 141. Further work is needed to obtain a satisfactory plume prediction.

Gain Scheduled Missile Autopilot Design Using Observer-Based $\mathcal{H}_\infty$ Control

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September 15, 1994

Abstract

This final report summarizes the research work performed at Wright Laboratory of Eglin Air Force Base by the author during the summer of 1994, sponsored by AFOSR Summer Faculty Research Program. It studies gain scheduled autopilot design in the pitch axis. To achieve the tracking specification with both stability and performance robustness for pitch autopilot design, frequency shaping is adopted and $\mathcal{H}_\infty$ optimization is employed. It is shown that with suitable modification of the design objective in [11], the resulting central $\mathcal{H}_\infty$ controller has an observer form and it can be computed without iteration. This is especially attractive for gain schedule implementation. Moreover, the proposed synthesis procedure has a two-step structure. In the first step, a state estimator gain is synthesized to achieve the desired sensitivity at the plant output. In the second step, a state feedback gain is synthesized to minimize the associated $\mathcal{H}_\infty$ cost of the objective function. This two-step procedure combines both advantages of the LQR/LTR in [16] and $\mathcal{H}_\infty$ loopshaping in [10] and is applicable to pitch autopilot design. The performance of a typical pitch autopilot synthesized by the proposed design method is then evaluated by computer simulations.

THERMAL MODELING OF HETEROJUNCTION BIPOLAR TRANSISTORS

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Abstract

Using Gummel-Poon model and a nonlinear simulator, effects of power dissipation on the performance of heterojunction bipolar transistors were studied. Emphasis is given to thermal effects on the output power at 1db gain compression point, output power at several higher order harmonics, intermodulation intercept and large signal S-parameters. Variation of these nonlinear phenomena with thermal impedance, frequency and thermal coefficients of the elements in the equivalent circuit was also studied in detail with an intention to optimize the linear power output.

REGRESSION TO THE MEAN IN HALF-LIFE STUDIES

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ABSTRACT

Half-life studies of biomarkers for environmental toxins in humans are generally restricted to a few measurements per subject taken at least one half-life after exposure. The initial dose is usually unknown because the exposure occurred before the substance was known to be toxic. In this setting, subjects are selected for inclusion in the study if their measured body burden is above a threshold (C), determined by the distribution of the biomarker in a control population. We assume a simple one-compartment first order decay model and a log-normal biomarker distribution, which together imply a repeated measures linear model relating the logarithm of the biomarker and time, with the slope being the negative of the decay rate (λ). Unless the data set is properly conditioned, we show that ordinary weighted least squares estimates of λ are biased due to regression toward the mean. In practice, the last measurement is taken to be greater than the threshold value C. Formulae are presented in the special case that 3 measurements per subject are available. Generalizations to k measurements per subject are straightforward.

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Abstract

The technical background and calibration of surface-obstacle skin friction meters were thoroughly reviewed in the 1993 Summer Program Final Report [1], and a summary was presented in [2]. The objective of the 1994 Summer Program was to complete the detailed design of the specific instrument proposed in [1], to initiate its fabrication, and to define test programs for facilities available at Wright Laboratory (WL) and Washington University (WU). These objectives were completed, fabrication of the instrument has been approved and is underway at Wright Laboratory, and calibration tests are tentatively scheduled in the WL M3 and M6 supersonic wind tunnels during 1995. An exploratory calibration project using a simple proof-of-concept prototype instrument was carried out under private funding in the Washington University Low-Speed Wind Tunnel, in April, 1994, and a thorough incompressible-flow reference calibration of the new WL instrument is planned for 1995.

SUMMARY OF THREE PAPERS:
I. AN EXPANDED VERSION OF THE KULHAVY/STOCK MODEL OF INSTRUCTIONAL FEEDBACK
II. LOGISTIC MODELS USING MULTIPLE INDICATORS OF RESPONSE STATE TO PREDICT SUBSEQUENT RESPONSE CORRECTNESS
III. GENDER AND DEVELOPMENTAL DIFFERENCES IN ACADEMIC STUDY BEHAVIORS

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Abstract

This report is a summary of three journal articles completed this summer. The results of previous papers and reports, including additional analyses, have been drawn together and reinterpreted. The first draws together literature regarding the Kulhavy/Stock model of instructional feedback, then summarizes data that support an expanded version of their model. It is suggested that the model include a higher order control system which accounts for learners' goals and which system governs the behavior in the lower order systems focused on responding correctly to instructional demands. It is further proposed that analyses and modeling be conducted on a subject by subject basis and that the use of feedback be understood more in terms of each learner's control systems and less in terms of an S-R or cause-effect orientation. The second summary reports measures of the response state of a learner as a means of predicting posttest correctness. It has been suggested that student modeling could incorporate more measures of the cognitive state at the time of responding. Comments are made regarding the future of such work.And finally, a paper is summarized which reports on what we believe is the initial source of study behaviors in adults: the development of such behaviors in elementary school children. Results provide explanations for persisting gender differences in the performance of complex academic tasks and demonstrate the importance of interpreting students' behaviors in terms of environmental and personalogical factors.

CIRCULAR WAVEGUIDE TO MICROSTRIP LINE TRANSITION

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Abstract

A circular waveguide to microstrip line transition was analyzed with a spectral-domain Green function / method of moments technique. The goal of this work was to obtain the equations for the moment method matrices as they appear in Appendix D. These spectral integral expressions for the matrix elements take into account all the available symmetries in the spectral polar coordinates k_t and α. Beyond this goal, much of the analysis was written into numerical subroutines. When run together the subroutines will be a useful design tool. This written computer code will help engineers design a reliable transition through the cooling boundary layer to the rf circuitry in a high density microwave monolithic integrated circuit package.

The second goal of this work was to develop a postprocessing routine which will calculate the reflection coefficient on a microstrip line given sampled values of the current on that line. A fairly robust routine described in the text was developed.

ADAPTIVE QUADRATIC CLASSIFIERS FOR MULTISPECTRAL TARGET DETECTION

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Abstract

This paper investigates the use of an adaptive quadratic classifier for multispectral target detection. The system is designed to exploit both mean and covariance differences between the target and background. The detector proposed here is based on a Gaussian Bayes classifier where the local background statistics are estimated adaptively. Thus, these statistics need not be known *apriori*, and the detector will adapt to changing backgrounds. In addition, a forward sequential band selection method using the Bhattacharrya distance criteria is investigated here. This metric measures class separability due to mean and covariance differences. Also, a linear feature extraction technique is examined for data reduction prior to classification. Bomem spectrometer data and Landsat Thematic Mapper (TM) imagery are used to obtain preliminary results.

A NEW MISSION FOR THE AIR FORCE PHILLIPS LABORATORY MALABAR TEST FACILITY

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Abstract

In spite of a long history of valuable support to a wide variety of DoD and NASA programs, the Air Force Malabar Test Facility in Palm Bay, Florida is currently suffering from a rather serious decline in funded technical activity, and therefore in manpower and capability. This applied research and strategic planning project provides an assessment of the Malabar Test Facility and identifies a new mission related to the commercialization of space in the United States. Four significant opportunities for future Malabar participation include: a major role in the Eastern Range Modernization and Automation Program, an enhanced role in dual-use research and operations, technology transfer to the commercial space launch business, and as a major participant in a University Center of Excellence in Space Education and Research.

Simulation of Erbium-doped Fiber Lasers

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Abstract

Numerical simulation of pulse amplification in birefringent optical fibers has been examined with the goal of providing a realistic and accurate description of passive mode-locking. Emphasis of our studies was put on the evolution of the pulse's polarization. We found a complex polarization state of the amplified pulse; this has important implications for the operation of fiber lasers using a birefringent fiber amplifier mode locking element.

EFFECT OF HUMIDITY ON FRICTION AND WEAR FOR FOMBLIN Z UNDER BOUNDARY LUBRICATION CONDITIONS

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Abstract

Using a Cameron-Plint tribometer under controlled environmental conditions, friction and wear were measured for Fomblin Z with M-50 steel under boundary lubrication conditions at 50, 100, and 150 C with relative humidity ranging from 5% to 100%. In general, both friction and wear decrease sharply as humidity is increased from 5 to 20%, then is constant as humidity increases to 100%. Thus, both friction and wear are highly dependent on humidity when relative humidity is less than 20%. Therefore, to improve repeatability of results, humidity should be measured any time Fomblin Z is being tested with steel specimens under boundary conditions, and carefully controlled if it is 20% or less.

HIGH RESOLUTION RANGE DOPPLER DATA AND IMAGERY FOR SPACE OBJECT IDENTIFICATION AND ANALYSIS

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Abstract

The following pages describe the raw data available from radar sites such as HAYSTACK, ALCOR, and MMW as well as several data processing and presentation options including Range Time Intensity (RTI) and Doppler Time Intensity (DTI) strips and Range Doppler (ISAR) imagery. Several image sequences are provided to demonstrate the effects of a) Angular Sampling Interval, b) Angle of Integration, c) Zero Padding of signals in the Range and Doppler Dimensions, d) Center or Operating Frequency, and e) Signal Bandwidth. These variables represent a minimal set of parameters necessary for both site characterization and image understanding. A thorough understanding of the image formation process represents a necessary and prerequisite step to automated or manual object identification and analysis.

PRELIMINARY RESULTS OF THE NEUROPSYCHIATRICALLY ENHANCED FLIGHT SCREENING PROJECT

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Abstract

The United States Air Force has yet to find useful predictive measures of success as an aviator. Within the spectrum of human factors, personality presents one variable, and if properly measured, may have predictive validity in determining who becomes a successful military aviator. Personality factors may also be useful in the cockpit assignment process. This study represents the first phase of the neuropsychiatrically enhanced flight screening project, a longitudinal study searching for valid predictive measures of success as a military aviator; and providing baseline psychological information about these candidates should it be needed. Candidates entering the Air Force enhanced flight screening program were tested using the following psychological instruments: Revised NEO Personality Inventory, Multidimensional Aptitude Battery, and Personal Characteristics Inventory. Results are evaluated for their usefulness in describing current flight training candidates. Discussion focuses on how these tests may help in selecting the best qualified pilot candidates (select-in measures) or ensuring candidates meet minimum standards (select-out measures).

AUTOMATIC CONTROL ISSUES IN THE DEVELOPMENT OF AN ARTIFICIAL PANCREAS

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Abstract

Recent developments in technology for the treatment of diabetes mellitus enable sensing and control of key chemical/hormone species related to the disease. Further, it is expected that non-invasive (infrared) blood glucose sensing techniques will permit continuous on-line sensing of blood glucose levels in insulin-dependent diabetics. It is thus desired to apply modern control systems design techniques in the design of an artificial pancreas in order to provide a robust, fault-tolerant design suitable for clinical and at-home use. A preliminary effort toward this goal was undertaken during the 1994 Summer Faculty/Graduate Student Research program at Eglin Air Force Base; a complementary study is presented by J. S. Naylor in Summer Research Program Report 21. The effort presented in this report comprises the development of (1) a qualitative model of endocrine kinematics related to glucose management and (2) a preliminary approach for system identification to be used in fitting these models to experimental data.

A REALISTIC MULTI-TASK ASSESSMENT OF PILOT APTITUDES

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and

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Abstract

The proposed study is an attempt to develop a realistic multiple task assessment tool for pilot selection. The approach taken is job analytic in the sense that the types of tasks that a pilot performs are examined first, and then based on the aptitudes that are considered to be involved, experimental tasks are designed to tap those aptitudes in their concurrent performance. Aptitudes considered include psychomotor, perceptual, information processing, and time sharing. It is also suspected that working memory and long-term memory are utilized in the efficient performance of the multiple task, hence structural models of task intercorrelations are described for subsequent empirical testing.

CAN DESIGN FOR COGGING OF TITANIUM ALUMINIDE ALLOYS

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Abstract

The design of can to break-down titanium aluminide ingots via cogging process was attempted. A large strain viscoplastic finite elements program DEFORM (Design Environment for Forming) was used to simulate the cogging process for the near-gamma titanium aluminide alloy Ti-45.5Al-2Cr-2Nb in a type 304 stainless steel can. Can and process variables investigated in the FEM simulations included can thickness, can geometry, and ram velocity. It was found that there is an optimum can thickness and ram velocity to obtain moderately uniform flow between can and titanium aluminide workpiece.

MULTIDIMENSIONAL ALGORITHM DEVELOPMENT AND ANALYSIS

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Abstract

Recent experience with multidimensional vortex dominated flows has given an indication that conventional algorithms in general do not live up to their traditional high–resolution capabilities. An interesting example is when field based methods of inferring vehicle loads which involve interrogation of the solution vortical field are used. It has been shown that these techniques can perform quite well yet are highly sensitive to spurious vorticity. Hence even seemingly minor errors in the vortical field can yield inadequate results. Another area of intense interest is computational aeroacoustics in which the degree of accuracy necessary requires extremely close attention to detail (physics) due to pertinent solution gradients being orders of magnitude smaller than that which the "high–resolution" schemes were designed. The effort here has been to develop and analyze a flow model incorporating multidimensional physics with only limited modifications to existing conventional flow software. Around 1986, Professor Charles Hirsch, et.al. presented a rather significant technique to optimally decouple the multidimensional Euler equations (inviscid equations of fluid motion). Although seemingly a rather impressive contribution to the computational community, the implementation of this mathematical technique has been quite cumbersome for those researchers so inclined to utilize it. In as such, the broad acceptance of this approach has not yet been borne out. Since that time, investigations into the true multidimensional modeling of the flow physics has yielded some intriguing (yet often complicated) new philosophical approaches to solving the flow in more than one spatial dimension. For this effort the flow domain is restricted to two–dimensions. The base software is a conventional finite–volume high–resolution approximate Riemann solver incorporating Roe averaging. Modifications were made to this software in order to utilize Hirsch's decoupling technique and multidimensional advection algorithm(s) presented in literature. This report focuses on an implementation of the multidimensional decoupling procedure which utilizes the fluctuation splitting theory outlined in literature yet does so on cell–centered quadrilateral–based data rather than on unstructured cell–vertex triangle–based data.

CHARACTERIZATION OF INTERFACES IN METAL MATRIX COMPOSITES

Iwona M. Jasiuk

Introduction

In composite materials the fiber-matrix interface plays a crucial role and it influences both the local stresses and the effective properties of composites (see e.g. Drzal and Madhukar, 1993). For example, stiffness and strength depend of the load transfer across the interface, toughness is affected by the fiber pull-out or crack deflection mechanisms, ductility is influenced by the relaxation of high stresses near the interface (Clyne and Withers, 1993). It is not surprising, therefore, that much of the recent research in the area of the mechanics of composite materials has focused on the interfaces, but due to the complexity of the subject many issues still remain unresolved. A fundamental problem in this area is how to characterize the interfaces.

In this research we focus on the characterization of interfaces in metal-matrix composites.

REED-SOLOMON DECODING ON CHAMP ARCHITECTURE

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Abstract

The CHAMP (Configurable-Hardware Algorithm-Mappable Preprocessor) architecture was developed at Wright Laboratory for computation intensive operations across a wide variety of avionic applications. It is oriented to high speed fixed point operations and is cost effective compared to special purpose VLSI chips or general purpose supercomputers. However, it is difficult to "program" the architecture, even when a sequential code is available. Reed-Solomon (R-S) decoding is an important task in many applications. It requires high speed fixed point operations and is therefore considered a good candidate to be implemented on CHAMP architecture. This three-month summer research effort was to study the feasibility of mapping R-S decoding on CHAMP and to generalize the results. The tasks performed include (1) Converted a FORTRAN code for R-S coding to C code, (2) Designed a R-S decoder with VIEWLOGIC schematic editor that results in a hierarchy of 37 schematics, some of them down to gate level, (3) Proposed a partition scheme that requires an utilization ratio of around 70% to 80% for the R-S decoder on CHAMP, and (4) Identified two basic types of nested-loops, namely, loops with shift-invariant dependence graphs and those without, and proposed corresponding solutions.

REVERSE-FLOW GAS GENERATOR STUDY FOR H_2/O_2 ROCKETS

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ASSOCIATE PROFESSOR

AEROSPACE ENGINEERING AND ENGINEERING MECHANICS

ABSTRACT

A preliminary study, using the ALLSPD CFD code (developed by NASA Lewis Research Center), on a proposed reverse-flow gas generator for full-flow staged H_2/O_2 rocket engines was conducted. Two-dimensional CFD simulations at different operating conditions were investigated. The mixing quality between combustion products from the preburner, which is operated at O/F=64, and the pure hydrogen diluent, which has temperature of 300 ^{0}K, was summarized in this report. The computational results indicated that at least five recirculation bubbles exist in the gas generator, and the temperature and species distributions are nearly uniform at the gas generator outlet. The results also implied that the center body of this gas generator may be overheated. This study concluded that the three-dimensional CFD simulation is needed to provide a better design guidance for the on-going Air Force gas generator program.

MODELING AND MITIGATION OF TERRAIN SCATTERED INTERFERENCE

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Abstract

A model for terrain scattered interference (TSI) or hot clutter is developed. This model includes all relevant TSI parameters such as spatial delay, doppler, and carrier phase angle. The effects of number of array elements, number of tap delays, TSI spatial delay, doppler, tap spacing, jamming angle of arrival, number of multipath signals, doppler spread, weight fixing time, relative bandwidth, and subbanding are examined. Recommendations concerning tap spacing, number of array elements, subbanding, weight lifetime, and the use of tap delay elements are presented.

NON-LINEAR OPTICAL PROPERTIES
OF A SERIES OF LINEAR TRIACETYLENES

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__Abstract__

Frequency dependent polarizabilities (α), first hyperpolarizabilities (β), and second hyperpolarizabilities (γ) were calculated for a series of linear triacetylenes: triacetylene; monosubstituted fluoro, cyano, nitro, amino, and planar amino triacetylene; disubstituted fluoro/amino, cyano/amino, and nitro/amino triacetylene, for both the planar and non-planar amine group. For each of the disubstituted nitro compounds, with the planar and the non-planar amino group, two conformations were studied. Calculations were made for the static (zero frequency) state and for E = 1.16527 eV (1064 nm). Statistical comparison of the 1064 nm data with the static data reveal linear relationships between the static values of α, β, and γ and the respective 1064 nm values for the polarizability, α; Second Harmonic Generation, β(a); Electro-Optic Pockels Effect, β(EOPE); Optical Rectification, β(OR); Third Harmonic Generation, γ(THG); Electric Field Induced Second Harmonic Generation, γ(EFISH); Intensity Dependent Refractive Index, γ(IDIR); and the Optical Kerr Effect, γ(OKE). Semiempirical calculations were made using MOPAC 93.

PHYSICAL WAVELETS FOR RADAR AND SONAR

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Abstract

Physical wavelets are localized functions in space-time $\mathbf{R}^4$ which (a) behave like typical wavelets in the sense that they generate bases or frames by translations and dilations, and (b) satisfy certain physical differential equations. For example, electromagnetic wavelets satisfy Maxwell's equations and acoustic wavelets satisfy the scalar wave equation. A class of such wavelets was defined and studied in [3], where some applications to radar and scattering were also proposed. Here we extend the theory by showing that physical wavelets can be generated by any one-dimensional function $\phi(\tau)$ satisfying some mild conditions. This opens the possibility for implementing the theory developed here through efficient computational algorithms such as multiresolution analysis.

BACKSCATTER FROM A PLASMA PLUME DUE TO EXCITATION OF SURFACE WAVES

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Abstract

Experiments conducted by Air Force Laboratories showed that considerable unexpected electromagnetic backscatter from a plasma plume is occuring in a certain intermediate frequency band. A plausible explanation for the backscatter is offered based on the excitation of surface waves.

For source frequency f less than plasma frequency f_p, the surface of the plasma column is an interface between free space and an overdense plasma which behaves like a conductor. The turbulent outer radial layer behaves like a rough surface. The plasma column is thus capable of supporting a TM surface wave.

The surface wave on the plasma column is analogous to a current wave along a wire antenna in the end-fire mode. When it encounters a spatial discontinuity in the properties of the medium in the axial direction of the column, it is reflected. The reflected wave gives rise to the backscatter.

The theory is illustrated through a sample calculation made at f = 600 MHz.

INVESTIGATION OF ATMOSPHERIC HEATING AND COOLING BALANCE USING MODTRAN3

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Abstract

Recent modifications to MODTRAN3, a 2 cm^{-1} resolution radiative transfer model, have permitted its transformation into a full flux divergence algorithm. It is now possible to calculate heating and cooling rates arising from both thermal and solar sources. The thermal calculations have been validated against benchmark line-by-line (LBL) calculations provided as an outgrowth of the InterComparison of Radiation Codes used in Climate Models (ICRCCM), organized by Ellingson and colleagues. The MODTRAN3 comparisons for separate species (H_2O, CO_2, and O_3) were all of sufficient quality, usually falling within the range of LBL comparisons, to warrant the extension to other species. MODTRAN3 now includes improved band model formulations, particularly for O_3, a new solar irradiance, absorption cross sections in the ultraviolet (SO_2 and NO_2) and infrared (CFC-11,-12,-13,-14,-21,-22,-113,-114,and -115, plus N_2O_5, HNO_4 and CCL_4), derived from the HITRAN92 data base.

A MACROSCOPIC MODEL OF ELECTROMIGRATION: COMPARISON WITH EXPERIMENT

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Abstract

Comparison of theory and experiment is critical in microelectronic reliability. In this work, a model which has been previously used for electromigration time to failure predictions (developed by Harrison) is extended to include predictions for numbers of voids and void sizes. Predictions from the model are compared to experimental measurements. The model makes reasonable predictions for mean lifetimes, numbers of voids, and void areas with very few free parameters. The model, however, does *not* adequately reproduce the of lifetimes found in experiment.

DISTRIBUTED SENSORY PROCESSING DURING GRADED HEMODYNAMIC LOADS

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Abstract

A new protocol was studied which will use cortical evoked responses to characterize how visual and auditory sensitivities are altered by physical workloads which produce hemodynamic stress. The cortical evoked responses will be measured during periods of fatigue. The subjects will be given simultaneous vestibular, visual and auditory stimuli. The stimuli will be random binary modulations which will allow the simultaneous responses to be identified for each stimulus.

APPLICATION OF THE MT3D SOLUTE TRANSPORT MODEL TO THE MADE-2 SITE

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ABSTRACT

The applicability of the public domain 3D solute transport code MT3D to model the migration of a conservative tracer and of reactive hydrocarbons at the MADE-2 site is investigated. To the author's knowledge this is the first time that MT3D has been applied to such a complex and heterogeneous groundwater aquifer system as is the MADE-2 site. The results of the study are very encouraging. In spite of the extreme numerical difficulties encountered initially with the code, which required several modifications and adaptations, MT3D has been able to mimic qualitatively the essential features of the tritium tracer plume and of the possibly biodegrading hydrocarbon p-xylene. Visual differences between the modelled and the observed tritium plume are noticeable after about 1 year after the start of the experiment and are to be attributed mainly to insufficient calibration of the head and flow fields computed by means of the MODFLOW model. Although more quantitative calibrations, using moment analyses of the observed and modelled plumes, and better numerical verification of the MT3D code must be left to future studies, it is the author's belief that this model has enormous potentials for unravelling some of the most important physico-chemical transport and fate mechanisms that have been proposed for the MADE-2 site by scientists at the Armstrong Laboratory. However, it also became clear during the course of the study that 3D flow and transport modelling requires extremely powerful computational platforms and, even more importantly, efficient 3D Graphics visualization software. The positive experience obtained from the latter serves also as a reminder to modellers who are still ingrained in a 2D thinking that their attempts to use classical 2D-contouring software will be inefficient, excruciatingly time-consuming, and still incapable of providing a full perspective of the complex 3D spatial model.

SEMICONDUCTOR CYLINDER FIBERS FOR FIBER LIGHT AMPLIFIER APPLICATIONS

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ABSTRACT.

We have measured the transmission spectrum of two type of Semiconductor Cylinder Fibers (SCyFs)at the Photonics Center of Rome Laboratories. These devices were fabricated by Syracuse University. The fiber preforms and SCyFs with CdTe and CdS semiconductor cylinders were tested. We have shown that the semiconductors survive the fabrication process. A number of fibers of each kind were tested with reproducible characteristics.

INVESTIGATIONS OF ELECTRON INTERACTIONS WITH MOLECULES: ELECTRON ATTACHMENT AND ELECTRON DETACHMENT REACTIONS OF HALOGENATED MOLECULES

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ABSTRACT

Reactions of electrons with a variety of halogenated molecules were explored using a Flowing Afterglow Langmuir Probe and mass spectrometer. Electron attachment to octafluorotoluene, pentafluorobenzonitrile, pentafluoroacetophenone, trifluorotolunitrile, and pentafluoropyridine results in the formation of a parent anion only, i.e., the association product is formed. Rate coefficients for electron attachment to these molecules indicate that these reactions are generally efficient (at 300K, k(octafluorotoluene) = 2.1 x 10 cm^3 s^{-1}, k(pentafluorobenzonitrile) ≥ 2.3 x 10 cm^3 s^{-1}, k(pentafluoropyridine) = 1.8 x 10 cm^3 s^{-1}). In two cases, reactions of octafluorotoluene and pentafluoropyridine, the anion formed is observed to detach electrons under our experimental conditions. Analysis of these data assuming that detachment is thermally controlled, indicates that the electron affinities of octafluorotoluene and pentafluoropyridine are < 1 eV. Chloroacetonitrile and pentafluorobenzene react with electrons to form ions which are fragments of the parent, i.e., dissociative attachment products. Attachment to chloroacetonitrile forming Cl^- is relatively efficient, k = 4 x 10 cm^3 s^{-1} at 300K and becomes increasingly more efficient as temperature is increased. Electron attachment to pentafluorobenzene appears to form at least two products arising from attachment followed by loss of an H atom and attachment followed by loss of a HF molecule. Work has begun on an analytical strategy to extend the range of molecules one can study with the Flowing Afterglow Langmuir Probe technique.

AN EXPLORATORY STUDY OF WEIGHTED FUZZY KEYWORD BOOLEAN RETRIEVAL WITH HYPERTEXT LINKS FOR THE CASHE:PVS SYSTEM

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Abstract

The purpose of this project has been to explore the possibilities of providing improved retrieval and browsing capabilities to the CASHE:PVS system. That system currently provides access to human engineering studies and allows users to navigate from one entry to another and to simulate ergonomic experiments in order to provide understanding and improved design. The use of keywords, weights, and fuzzy Boolean logic was explored last summer in order to demonstrate the feasibility of that approach to improve the retrieval capabilities of CASHE:PVS, based in large part on the series of sample queries constructed for CASHE:PVS and known as the Design Checklist. This summer, demonstration of the feasibility of automatically generating additional hypertext links between EDC entries based on a similar approach involving term frequencies was accomplished. Future steps needed to expand this approach and this methodology and to integrate them into the CASHE:PVS system are presented.

Ionospheric Tomography Using a Model Based Transformation Maximum Entropy Technique

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Abstract

Ionospheric tomography uses total electron content (TEC) data obtained from a series of ground-based receivers and orbiting beacon satellites to determine the corresponding ionospheric electron density. The geometry of this technique does yield enough information to uniquely determine the ionospheric electron density unless additional information or assumptions are utilized. In this work a solution technique that can utilize both ionospheric model information and an entropy weighting for variations of potential solutions from a given model ionosphere has been developed. Results from both simulated and actual TEC data have yielded reconstructions that closely match the associated electron densities.

LAMB WAVE SCANNING OF A MULTILAYERED COMPOSITE PLATE SPECIMEN

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Abstract

In this research a new scanning technique using leaky Lamb waves is developed and applied to detect internal defects in a multilayered composite plate specimen. Images generated by this new Lamb wave scanning technique (L-scan) are compared with the conventional C-scan images. This comparison shows that the L-scan technique is more effective for detecting some internal defects such as fiber breakage and matrix burned out zones in a multilayered specimen than the C-scan technique.

Apoptosis, Advanced Glycosylated End Products, Autofluorescence and Nitric Oxide as related to Hyperbaric Oxygenation Therapy

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Abstract

We studied the free radical Nitric Oxide and its effects on apoptosis (programmed cell death) and non- enzymatic glycosylated end products (AGEs). The work involved the antigen-presenting dendritic cell, cells from an environment of high glucose concentration, and rat cells under the stress of microwave radiation. The Griess Reagents were used in the assays of nitric oxide. Flow cytometry was used in much of this work.

Studies of Plasma Turbulence with Versatile Toroidal Facility for Space Plasma Research

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Abstract

We have conducted laboratory experiments with the Versatile Toroidal Facility (VTF) to investigate plasma turbulence, aimed at simulating the space plasma environment and cross-checking some space plasma experiments. Several students of mine including Dan Moriarty participated in the experiments. Dan Moriarty worked at the Geophysics Directorate of the Phillips Laboratory under the AFOSR sponsored Summer Graduate Student Research Program. VTF is a large plasma device which can generate magnetized plasmas with sharp density gradients and intense magnetic field-aligned currents. The VTF Plasmas have the key characteristics of the space plasmas, especially in the auroral region. Our experiments show that the VTF plasma turbulence is structured with both high-frequency and low-frequency wave modes. Such a plasma turbulence can be similarly produced by the sharp plasma density gradients and/or field-aligned currents in the ionospheric F region and in the topside ionosphere. The results of the VTF laboratory experiments are compared with those of the rocket experiments in space. We show that VTF can adequately simulate the naturally occurring plasma turbulence in the auroral ionosphere and complement the active plasma experiments in space.

A STATISTISCAL METHOD FOR TESTING COMPLIANCE

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Abstract

In recognition of exposure variability a new statistical method, based on a hypothesis testing approach, is proposed for testing whether it is still in-compliance with the OSHA's standard if the Worker's overall-average exposure level is several times the OSHA's PEL. The asbestos exposure data collected at Lackland AFB is used as an illustration. This data set, consisting of personal samples from six workers exposed to asbestos, possesses several interesting features. Fisrt, the mean exposure level for some workers has changed during the entire exposure period. To detect changes in the mean exposure level a rank cusum chart was applied. Second, the sampling errors between workdays for all workers are highly autocorrelated. An autoregressive transformation was needed to remove the autocorrelated errors from the data. It was noticed that if the autocorrelated errors were not removed, a straight calculation of the exposure variability could be erroneous. Third, it was shown that even if the Worker's overall-average exposure level is several times the OSHA's PEL, it could still be in-compliance with the OSHA's standard. Finally, through the use of the ANOVA model, it was shown that the longitudinal exposure variability is the dominating one which could be from 2 to 8 times the cross-sectional variability. However, the longitudinal variability might be artificially inflated because of a small sample size for each workday. To settle for a more definite conclusion about the relationship between the longitudinal and the cross-sectional variability, more samples need to be collected from more workers.

SELF-PULSATION AND OPTOELECTRONIC FEEDBACK-SUSTAINED PULSATION OF LASER DIODES AT 1300 NM

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Abstract

Transient self-pulsation has a lifetime of a few minutes with frequencies up to 7 GHz. The linewidth of self-pulsation is on the order of 0.5 GHz. With optoelectronic feedback, the transient self-pulsation can be stabilized and enhanced. The center frequency of feedback-sustained pulsation is dependent on the passband of the bandpass filter in the feedback loop. The linewidth of feedback-sustained pulsation is significantly reduced to about 20 kHz. The optical spectra of the laser diodes exhibit coherence collapse at weak optoelectronic feedback. The feedback sustained pulsation can be frequency modulated. Applications of the feedback-sustained pulsation include subcarrier multiplexing optical networks.

HIGH RESOLUTION RANGE SIGNATURE ESTIMATION

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Abstract

This report presents a robust parametric data model for estimating high resolution range signatures of radar targets. This paper also presents an estimation algorithm for the data model. The algorithm is referred to as the APES (Amplitude and Phase Estimation of a Sinusoid in unknown colored noise) algorithm. We shall describe how the APES algorithm can be used to estimate range signatures. We shall show, with both numerical and experimental examples, that our modeling and estimation approach yields better resolution and lower sidelobes than the conventional nonparametric FFT (fast Fourier transform) method. We shall also show that our approach is more robust than modeling the radar data as a certain number of complex sinusoids in noise and estimating the frequencies, amplitudes, and phases of the sinusoids with one of the best sinusoidal parameter estimation methods.

PREDICTION OF MISSILE TRAJECTORY

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Abstract

This study concerns the survivability of an airship that is under attack by a missile. The pilot may employ an appropriate maneuver or countermeasure at the right moment to escape from the attack. Real-time prediction of the missile trajectory will help prepare the pilot to take action at the right moment to survive. The missiles considered have a short boosting period followed by a non-powered period. The proposed technique takes some missile trajectory data at the early stage of the non-powered period to estimate two of the most important missile parameters for predicting the future trajectory. The complete flying course of the target airship must be known for the prediction. Nine sets of trajectory data, three sets from each of three different types of missiles, are available for this study. One of these nine is not used because the impact happens during the boosting period. The developed technique generated good prediction results on these missile flyout data. One merit of the proposed technique is that no priori knowledge about the missile is needed. Indeed, throughout this study, no information about these missiles has been made available to this researcher. Prediction for the earlier trajectory of the missile including the boosting period has not been studied but relevant issues have been addressed and discussed in the introduction and discussion sections.

THREE DIMENSIONAL GEOMETRY MEASUREMENT OF TIRE DEFORMATION BY MEANS OF AN OPTICAL TECHNIQUE

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Abstract

The main objective of this research was to apply an optical technique called fringe projection to quantifying aircraft tire deformation and strains. Unlike Moire Fringes, the proposed technique using a single light source and only one grating requires no image superposition. As a result, the measurement is not as sensitive to vibration as the Moire method does. The other objective was to compare the magnitudes of three dimensional deformation between two types of F16 aircraft tires made of distinct tire cords, namely Bias and Radial, subjected to loading conditions such as with flat plate and flywheel, different percentages of tire deflection and different yaw angles. Since the optical technique used is based on the geometrical change relative to the selected reference point within the tire, a close-range fiber optic displacement sensor was installed to accurately detect the point's height change in the direction parallel to the wheel axle. The experimental results indicates that with the measuring system and the proposed technique, the tire deformation can be quantified and the three dimensional geometry of a deformed tire can be reconstructed.

A MODEL TO MONITOR THE CURRENT GAIN LONG-TERM INSTABILITY IN AlGaAs/GaAs HBTs BASED ON NOISE AND LEAKAGE CURRENT CHARACTERISTICS

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Abstract

A simple model is developed to monitor the dc current gain long-term instability in the AlGaAs/GaAs heterojunction bipolar transistor (HBT). It is derived from the theory that the recombination current at the extrinsic base surface increases with time due to the surface degradation process. Furthermore, the initial 1/f noise and base leakage current characteristics have been used to provide the needed model parameters for the HBT surface recombination mechanism and surface quality, respectively. The current gain long-term variations calculated from the model for four HBTs compare favorably with those obtained from measurements. The model developed can be used to screen unreliable HBTs without having to carry out the long-hour stress test.

PRELIMINARY REPORT ON THE FEASIBILITY OF MACHINE SPANISH DIALECT IDENTIFICATION AND DESCRIPTION OF LATIN AMERICAN DIALECT DATABASE (LADD) DEVELOPMENT

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Abstract

The feasibility of machine Spanish dialect identification based on phonetic, lexical, syntactic or prosodic characteristics is investigated. It is concluded that prosody is a promising direction to pursue. The development of a digitized Latin American Dialect data base is described.

A STUDY OF INTERACTION IN DISTANCE LEARNING

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Abstract

Interaction in distance learning was studied. A survey of the literature found that most studies were lacking in rigor and the methodologies were weak in regards to interaction. To answer the many questions about interaction effects in distance learning, a better definition of the variable interaction is needed. This paper lays out a taxonomy of interaction for evaluation and research.

NUMERICAL RECONSTRUCTION OF HOLOGRAMS

IN ADVANCED BALLISTIC HOLOGRAPHY

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Abstract

The feasibility of numerical reconstruction of real holograms was studied. The fringes of real holograms are resolvable in good quality microscopes operating with visible light. Photographs of the hologram through the microscope can be made and scanned into a computer. A formalism based on the Fresnel approximation to Huygen's principle is developed leading to a mathematical simulation of the physical process of hologram reconstruction. The numerical intensive part is reduced to a two dimensional Fourier transform, to which the FFT can be applied. The formalism is successfully applied to numerically generated holograms.

A WAVELET-MULTIGRID APPROACH TO SOLVING PARTIAL DIFFERENTIAL EQUATIONS BASED ON FRACTAL FUNCTIONS

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Abstract

A Wavelet-Multigrid approach to solving partial differential equations based on fractal functions is presented. The scaling functions and wavelets in this method are piecewise C^1 fractal functions supported on intervals of length at most 1. This new approach is ideal for solving boundary value problems and gives exact formulas for inner products of the form $\int_{\mathbb{R}} \eta'\eta'\,dx$, $\int_{\mathbb{R}} \eta\eta'\,dx$, and $\int_{\mathbb{R}} \eta^2\eta'\,dx$, where η represents a fractal scaling function or fractal wavelet. Furthermore, the preconditioner for the algebraic system, derived from the weak formulation of the differential equation, is obtained via a recursive and exact procedure that is based upon properties of the underlying fractal scaling functions and fractal wavelets.

INTEGRATED INFORMATION MANAGEMENT FOR ATR RESEARCH AND DEVELOPMENT

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Abstract

A wide variety of alphanumeric, spatial, signature, modeling and image data is collected to support ATR research and development. ATR algorithm design, development and evaluation completely rely upon this data. Since the cost of both data collection and algorithm development is quite high, an efficient management of the necessary data is a minimum requirement for a successful ATR development program. With respect to the management and usage, the diversity and huge volume of this information pose some major challenges. To store, manipulate, and manage this diverse set of information, an integrated information management system that is capable of efficiently storing, retrieving, and manipulating alphanumeric, spatial, and multidimensional image information and pertinent algorithms need to be designed and implemented. This report discusses the central features and requirements of such an integrated ATR information management system (IAIMS), reviews the existing data management structures used by WL/AARA and its contractors, and outlines the key design and implementation issues.

A REVIEW OF NONFILLED INTRINSICALLY CONDUCTIVE ELASTIC MATERIALS

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ABSTRACT

The literature relating to nonfilled, intrinsically, electronically conductive elastic materials was reviewed. Metal or carbon filled elastomers and materials with ionic conductivity were excluded. Two major groups of conductive, elastic materials were found to exist. One group consisted of polymeric quaternary ammonium salts complexed with 7,7,8,8-tetracyanoquinodimethane. The other group was composed of graft copolymers and blends of conductive polymers with an elastomeric material.

A NOVEL DESIGN CONCEPT FOR A SMALL, FORCE REFLECTING, TWO DEGREE OF FREEDOM JOYSTICK

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Abstract

A force reflection technology has been a source of research at the Armstrong laboratory for over a decade. It has been applied to areas ranging from simulation of complex G-fields in a static 1-G environment, to the development of force reflection joysticks for general scientific research in manual control, to looking at the specific application of force reflection joysticks to aid people with muscular spasticity.

It is desired to design smaller, force reflection joysticks aimed at specific, practical applications. However, it is also desired for these new designs to retain as much adaptability as the previous designs. Unfortunately, adaptability of these joysticks come at a cost not feasible for everyday applications.

This effort introduces the use of magnetic particle brakes as a possible actuator for smaller, force reflection joysticks aimed at specific, practical applications. The overall cost of such joysticks could be as little as one tenth the cost of a conventional force reflection joystick.

CATALYTIC GASIFICATION OF PITCH CARBON FIBERS WITH SILVER, CERIUM OXIDE, AND PRECIOUS-METAL-DOPED CERIUM OXIDE

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Abstract

Pitch carbon fibers have been gasified with silver metal as the catalyst to produce large geometric-shaped cavities which extend well into the fiber structure. The presence of large cavities was confirmed by: 1) Atomic Force Microscopy of the gasified fibers, 2) nitrogen adsorption to determine the surface area, 3) absence of macro-sized pores as determined by mercury porosimetry, and 4) adsorption of a colloidal oxide sol into the fiber structure. The failure of silver to generate the desired smaller sized pores for the fibers investigated was determined to be due to silver agglomeration to form large particles. Extensive silver agglomeration was even established for the case when a silver sol was deposited onto the fiber surface. The gasification of pitch fibers was also investigated in the case where cerium oxide was adsorbed onto the fiber surface in the form of a sol of ca. 4 nm diameter. Although this oxide was less active than silver in the gasification reaction, the oxide structure would make agglomeration on the fiber surface less likely than the problem identified with silver. It was discovered that by doping the cerium oxide, or ceria, surface with silver, platinum, or rhodium, that the gasification was enhanced. This enhancement is due to the modification of the redox properties of the ceria surface itself due to the precious metal oxide redox contribution. In contrast, palladium doped onto the ceria surface showed no enhanced catalytic function over that of ceria. The fact that the gasification temperature was lowered by 150°C compared to ceria in the case of silver-doped ceria suggests that there is a strong possibility of modification of the pore structure formed by the ceria versus the silver-doped ceria particles acting as the gasification catalyst. The comparison of the pores formed within the fibers from these two novel gasification catalysts will be determined in future work.

AUTOMATIC EXTRACTION OF DRAINAGE NETWORK FROM DIGITAL TERRAIN ELEVATION DATA

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Abstract

In this report a straight forward approach for automatic extraction of drainage network from Digital Terrain Elevation Data (DTED) of the Defense Mapping Agency (DMA) is presented. The approach is based on common image processing methods such as frequency domain filtering, spatial domain histogram equalization, binarization, thinning and other techniques. The approach has been examined with several DTED files. The results obtained from this approach are as good as, or better than, other methods. The approach was developed using Khoros image processing system and C programming. Khoros has excellent visually based environment and its rather extensive library of functions helped avoid writing of commonly used codes.

THERMOPHYSICAL AFFINE INVARIANTS FROM IR IMAGERY FOR OBJECT RECOGNITION

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Abstract

An important issue in developing a Model-Based Vision approach is the specification of features that are - (a) invariant to viewing and scene conditions, and also - (b) specific, i.e., the feature must have different values for different classes of objects. We formulate a new approach for establishing invariant features. Our approach is unique in the field since it considers not just surface reflection and surface geometry in the specification of invariant features, but it also takes into account internal object composition and state which affect images sensed in the non-visible spectrum. A new type of invariance called Thermophysical Invariance is defined. Features are defined such that they are functions of only the thermophysical properties of the imaged objects. The approach is based on a physics-based model that is derived from the principle of the conservation of energy applied at the surface of the imaged object.

RELAXATION PROCESSES IN GAIN SWITCHED IODINE LASERS

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Abstract

The dynamics of a gain switched, low pressure photolytic iodine laser were investigated experimentally and theoretically. The pulse shape, build-up and decay time were measured as function of the pressure of the active medium (CF_3I) and of the pressure of the buffer gas. At low pressure, the pulse develops a second peak, and the build-up and decay times become longer. The distinct features of the iodine pulse could be explained in terms of two relaxation processes involving collisions that change the direction and magnitude of the velocity vector. A computer model based on the rate equations which includes collisional relaxations allowed us to derive quantitative estimates for the corresponding relaxation times as a function of pressure and buffer gas.

PREPARATION AND CHARACTERIZATION OF BLENDS OF ORGANIC POLYMERS WITH NOVEL SILSESQUIOXANE MATERIALS

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ABSTRACT

Polyhedral oligomeric silsesquioxane (POSS) materials are an important class of compounds having an oxygen:silicon ratio of 1.5, intermediate between that found in silicones and silica. Blends of three different POSS compounds, two monomeric (fully cyclohexylated T6 and fully cyclohexylated T8), and one a polymer [a poly(POSS)methacrylate], with two different organic polymers, poly(methyl methacrylate) (PMMA) and a thermoplastic elastomer based on a block copolymer of poly(tetramethylene ether) and nylon 12 (PEBAX 2533), were prepared by dissolving the materials to be blended in a common solvent and evaporating the solvent. The resulting blends were characterized by Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC). The blends with the monomeric POSS compounds, in which the POSS compounds were intended to serve as filler materials, appeared to phase separate more than the blends with the poly(POSS)methacrylate. Blends of poly(POSS) methacrylate with PMMA gave clear films at up to 6% loading of the POSS material, and clear films with PEBAX at up to 50% loading. The clear films with PEBAX whitened, however, upon stretching, suggesting that phase separation could be stress induced. The results of the TGA analyses showed that the solvent was never completely removed from blends containing PMMA regardless of the drying procedure employed, while solvent was always completely removed from the blends containing PEBAX. TGA traces of blends showed that there was little effect of POSS at low levels, but at higher levels traces became more like those of the POSS. Low levels of POSS had no effect on the T_g of PMMA and the T_g of the PEBAX was unaffected by any POSS at any level. Higher levels of POSS increased the T_g of PMMA by 5 to 10C. Low-temperature, low-energy endothermic transitions were observed in the DSC for the three POSS compounds; these were not observed in the glassy blends with PMMA, but were seen, shifted, in the rubbery blends with PEBAX.

INFRARED IMAGES OF ELECTROMAGNETIC FIELDS

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Abstract

A new infrared (IR) imaging technique is being developed to measure two-dimensional electromagnetic (EM) field distributions near a radiator or a scattering body. Both electric and magnetic field intensities can be measured with this technique. Initial tests to prove the validity, accuracy and sensitivity of this new technique were performed this summer in the anechoic chamber at the Electromagnetic Vulnerability Analysis Facility (EMVAF) at Rome Laboratory (RL).

External radiation tests were performed on a conducting cylinder irradiated by an incident plane wave. E- and H- field patterns of the scattered/diffracted energy from the cylinder where measured. Tests were conducted at various microwave frequencies relative to the resonant frequencies associated with the cylinder and at numerous angles of incident (eg. end-on, broad-side, oblique-incidence) and at several different polarizations of the incident field relative to the axis of the cylinder (eg. horizontal, vertical, and skewed). Tests were performed in the near and far fields of the cylinder.

Internal coupling tests were performed to determine the induced energy coupled through long, thin slot apertures at various orientations in the side of the cylinder (eg. axial and longitudinal slots).

The scattering characteristics of several dielectric cylinders and spheres were also tested. Metallic and dielectric half-cylinders and half-spheres were tested for their scattering characteristics.

The radiation pattern of a standard gain horn (aperture antenna) was determined using the IR imaging technique. Radiation patterns in the E and H planes were taken in the near and far fields of the horn aperture. Several cross-sectional patterns were also taken in the near field of the horn and in the aperture plane.

These simple, canonical objects were tested to validate the accuracy of the IR technique. In all validation tests, the relative error was typically only 7 to 8 percent. Therefore, this new EM measurement technique, if further developed, has the potential to provide extremely accurate EM field measurements.

Three papers were presented at international IR and EM conferences this summer; three seminars were also presented on the technique. One paper has been submitted to an IR journal for publication; three new papers have been submitted for presentation at several IR conferences next year.

SURFACE OUTGROWTHS ON LASER-DEPOSITED $YBa_2Cu_3O_7$ THIN FILMS

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Abstract

The surface morphology of $YBa_2Cu_3O_7$ thin films formed on (001)-oriented $LaAlO_3$ substrates by pulsed-laser deposition has been examined using both scanning probe microscopy and transmission electron microscopy. Under certain deposition conditions a high density of surface outgrowths is observed. These outgrowths have been determined to be primarily $YBa_2Cu_3O_7$ grains oriented such that the c-axis of the unit cell is lying parallel to the film/substrate interface plane. The size and number density of these outgrowths do not vary significantly with deposition time, which suggests that they nucleate at the substrate surface at the same time as do the grains oriented with their c-axis perpendicular to the film/substrate interface plane.

COMPUTER CALCULATION OF RATE CONSTANTS FOR BIMOLECULAR REACTIONS

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ABSTRACT

The objective of this research was to attempt to calculate the rate constants for bimolecular reactions by combining the modified Angle-Dependent Line of Normals model with semi-emperical or *ab initio* quantum calculations for potential energy surfaces. The bimolecular reactions under consideration are those which are currently being investigated experimentally at the Environics Division at Tyndall Air Force Base. In particular, we concentrated mainly on the [illegible] $IO + Cl \rightarrow I + ClO$ and $CF_3I + OH \rightarrow CF_3 + IOH$. We found that the semi-emperical p[illegible] was not sufficiently accurate to estimate the potential for these reactions, and have begun calculating potential energy surfaces using the *ab initio* package GAUSSIAN. We also detail the similarities and differences between normal transition state theory and the modified Angle-Dependent Line of Normals model, and outline some of their underlying assumptions. In addition, relaxed MOPAC structures are presented for some of the molecules which are currently being experimentally investigated.

A REVIEW OF PARAMETER SELECTION FOR PROCESSING CYLINDRICAL HEAD SCAN DATA

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Abstract

Full field surface data of cylindrically shaped objects, such as a human's head, can be acquired by rotating a triangulated laser and imaging system about the subject. The method of acquisition is imperfect and requires post processing of the data obtained. To eliminate rough or irregular surface data, a two-dimensional convolution can be used. To eliminate spikes or impulse noise in the data, morphological filters are available. Proper use of both operations requires knowing and understanding the operational parameters. This report presents an overview of these methods and discusses the optimal parameter settings that have been determined by experimentation.

The Importance of Lower Orbital Relaxations in Polymer Band Gaps:
Failure of the Frozen Orbital Approximation

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Abstract

Theoretical calculations were performed on oligomers of all trans polyenes ranging from C_2H_4 to $C_{40}H_{42}$. All calculations used the GAMESS molecular orbital package. *Ab initio* calculations using the 6-31G* basis set were done on oligomers C_2H_4 to $C_{20}H_{22}$. The energies of the geometry optimized ground states of the oligomers were computed at the RHF level. The energies of the singlet and triplet excited states were calculated using the same basis set by a minimal configuration interaction (CI). In these CI calculations the ground state geometries were used; and all ground state orbitals but the HOMO and LUMO were frozen. In the limit of infinite chain length the energy difference between the HOMO and LUMO linearly approached hartrees 6.80 eV. The energy differences between the ground state and the CI excited states were also computed. The values of the coulomb and exchange integrals of the polyenes were computed.

Semi-empirical calculations were done on oligomers C_2H_4 to $C_{40}H_{42}$. Geometries were optimized at the AM1 level and the ground state energies computed. The energy of the triplet excited state was computed using the ground state geometry, but allowing full electronic relaxation in the ROHF approach. The HOMO-LUMO gap extrapolated to 6.17 eV. The energy difference between the ground state and the triplet excited state extrapolated to 1.67 eV. This result, in excellent agreement with the experimentally measured band gap in polyacetylene demonstrates that computation o[illegible]rate band gaps for polymers requires that electronic relaxation of excited state wavefunct[illegible]llowed. Most previous workers have done no excited state calculations for polymer ba[illegible]but have merely extrapolated the value of the HOMO-LUMO gap as obtained from ground state calculations.

IMPROVING THE UNITED STATES AIR FORCE ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PLANNING

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Abstract

This paper presents salient points resulting from a summer faculty research study and technical report on technology development planning that emphasized the environmental area of "sludge". Improvement considerations are recommended in areas of organization, and strategic policies for long-range technology development and prioritization. These four recommendations should be applicable to all government organizations, development centers and industry dealing directly or indirectly with technology developments to meet environmental needs and objectives:

(1). Improve the "INTEGRATION and TEAMING" of functional areas.

(2). Adopt "RETURN-ON-INVESTMENT" (R.O.I.) as a primary component of the prioritization scheme for supporting research and development.

(3). Adopt the long-term thrust area of "TOTAL PROCESS CONTROL" for waste treatment and disposal as the ultimate reuse/recycle technology development planning objective.

(4). Adopt the planning objective of "COST COMPETITIVENESS" from the perspective of industry and government for use in decision processes in technology development including benchmarking and technology transition.

COMMUNICATIVE CHALLENGES FACING INTEGRATED PRODUCT TEAMS IN A HIERARCHICAL ORGANIZATION: A CASE STUDY

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Abstract

The special organizational challenges that face integrated product teams in a strongly hierarchical setting were explored. Military organizations such as the USAF exhibit high levels of vertical differentiation. That is, individuals and organizational units are related to one another hierarchically. The shift toward integrated product teams introduces a strongly contrasting model in which hierarchical relations are flattened and divisions based on function and technical specialty are crossed. This study represents an initial examination of the problems that arise when a unit based on integrated product teams (IPT's) is introduced into a strongly hierarchical organization. Specifically, this study focused on the Office for Prevention and Health Services Assessment (OPHSA) within the USAF. Three classes of organizational challenges were identified as part of a qualitative, participant-observation research project. These were: 1) intraorganizational conflict that arose when a new, flatter organizational structure was "grafted" into a larger, more hierarchical parent structure; 2) problems of cross-technical communication that arose when IPT members with different functional or technical specialties must work together; and 3) problems of role conflict and status ambiguity that arose within the new unit when members' tenure and rank were de-emphasized.

PERFORMANCE OF MUSIC AND MONOPULSE ALGORITHMS IN THE PRESENCE OF RADOME REFLECTIONS AND MUTUAL COUPLING

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Abstract

In this report we investigate the behavior of two direction finding algorithms under actual operating conditions rather than ideal conditions. These two algorithms are: 1) the Iterative Monopulse algorithm and 2) the MUSIC algorithm. The Iterative Monopulse algorithm is simple and efficient to use and does not demand excessive computational capacity but has a resolution dictated by the Raleigh criterion. When the spectrum is sparsely populated this algorithm gives accurate answers in an efficient fashion. The MUSIC algorithm is capable of super resolution beyond that dictated by the Raleigh criterion. The performance of these two algorithms is studied under realistic conditions wherein the effects of reflections from radome walls and the mutual coupling between elements of the array are included. The input data for this study is obtained from two sources. An electromagnetic code simulating the radome is used to generate the fields inside the radome. This data includes the effects of radome scattering on the wavefront distortion inside the radome but does not include the effects of mutual coupling. The second set of data is obtained from experiments carried out in a compact range on 16-horn array. Simulation results clearly indicate the degradation in the performance of both the algorithms. Also, the MUSIC algorithm is much more vulnerable to non-ideal conditions than is the Iterative Monopulse algorithm. It has been shown that the effects of mutual couplings can be compensated for using the mutual impedance matrix which is aspect insensitive. It remains a challenging problem to compensate for a near field scatterer in general and the radome in particular since these scattered fields are aspect dependent. Several lines of further research are suggested to overcome these problems.

AN ASSESSMENT OF THE WL/AAAI-4 ANTENNA WAVEFRONT SIMULATOR

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Abstract

Wright Laboratory has designed and constructed a one-of-a-kind Antenna Wavefront Simulator (AWFS) to produce signals that replicate those at the terminals of the elements of an antenna array. Such a unique research and development platform provides a compact, economic test environment upon which adaptive array electronics packages can be developed and tested. Furthermore, the AWFS could eliminate the need for testing in an anechoic chamber or open range until final test.

One of the most critical design issues raised in the development of the AWFS was the use of analog, linear phase shifters, instead of (tapped) delay lines, to produce the appropriate wavefront signals at respective elements in the array. Delay lines have been the traditional approach as they readily characterize a wavefront incident upon an array by delaying all frequency components in that wavefront by the same period of time. Phase shifters, on the other hand, are typically assumed to produce a constant phase shift, even over a band of frequencies. Consequently, phase shifters have never been used in wavefront simulation of broad band signals. Therefore, the purpose of this report is to describe in detail how phase shifters with a linear phase shift capability are the functional equivalent of delay lines, even for replicating wideband signals. Also, other aspects of the AWFS are discussed, and recommendations for future direction of its development are offered.

A SURVEY OF LITERATURE ON FUNCTION DECOMPOSITION

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Abstract

This report surveys the literature on decomposition of binary, multiple-valued, fuzzy and continuous functions. It gives also references to relevant basic logic synthesis papers that concern topics important for decomposition, such as for instance representation of Boolean functions or symmetry of Boolean functions.

As a result of the analysis of the most successful decomposition programs for Ashenhurst-Curtis Decomposition, several conclusions are derived that should allow to create a new program that will be able to outperform all the existing approaches to decomposition. Creating such a superior program is necessary to make it practically useful for applications that are of interest to Pattern Theory group at Avionics Labs of Wright Laboratories.

In addition, the program will be also able to solve problems that have been never formulated before. It will be a test-bed to develop and compare several known and new partial ideas related to decomposition. Our emphasis is on the following topics:

1. representation of data and efficient algorithms for data manipulation,
2. variable ordering methods for variable partitioning to create bound and free sets; heuristic approaches and their comparison,
3. use of partial and total symmetries in data to decrease the search space,
4. methods of dealing with strongly unspecified functions,
5. special cases of decomposition, that can be efficiently handled (cascades, trees without variable repetition).

AURALLY DIRECTED SEARCH: A COMPARISON BETWEEN SYNTHESIZED AND NATURAL 3-D SOUND LOCALIZATION ENVIRONMENTS

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<u>Abstract</u>

The present report describes the first two experiments of an extensive series that are currently being conducted on the application of spatial information derived from auditory signals upon visual processing: more specifically, this research investigates the impact of acoustic information upon a human subject's ability to locate and identify visual targets (maintenance of situational awareness). The results of the first experiment confirmed earlier reports (Perrott, Saberi, Brown and Strybel, 1990) that aurally directed visual search was substantially more efficient than unaided search even when the field to be scanned extended a full 360 degrees in azimuth and nearly a full 180 degrees in elevation. This baseline experiment was repeated with audio signals presented over earphones (a 3-D synthesized sound field). Performance in the latter situation was essentially identical to that encountered in the free field (i.e., natural environment), especially for visual targets initially located in the frontal hemi-field. These results indicate :(1) that free field listening environment can be generated in obviously non-free field situations (such as a cockpit of an aircraft) with little loss in the utility of the derived spatial input and (2) that such information can substantially improve the human subject's ability to process visual information.

INFRARED IMAGING FOURIER TRANSFORM SPECTROMETER (IRIFTS)

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Abstract

Infrared spectra were obtained using a commercial Fourier Transform Infrared Spectroscopy (FTIR) spectrometer that was stripped for use with available imaging optics. This allowed a detector array to be used in the place of the usual single detector. Both an image and the IR spectrum at each image point were observed with this IR system. Demonstration of the high throughput concept was successful, with an IR spectrum from all detectors of the array yielding a spectrum identical in detail with the IR spectrum from any individual detector of the array.

DOSE RESPONSE STUDIES FOR HYPERBARIC OXYGENATION THERAPY

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Abstract

The primary goal of this summer's research was to identify appropriate dose-response studies as a basis for the determination of optimal hyperbaric oxygenation therapy regimens. Several specific responses to hyperbaric oxygenation therapy were examined including; white blood cell surface protein expression, nitrite production and apoptosis. Preliminary results indicate that hyperbaric oxygenation may be utilized to both suppress deleterious immune responses while enhancing advantageous immune response.

ANYTIME INFERENCE AND DECISION METHODS

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Abstract

We examine methods of decision making that are able to accommodate limitations on both the form in which uncertainty pertaining to a decision problem can be realistically represented and the amount of computing time available before a decision must be made. The methods are *anytime algorithms* in the sense of Boddy and Dean [1989]. An anytime adaptation of Nilsson's [1986] probabilistic logic is developed. Decision making techniques are presented for use with this system of logic, with Frisch and Haddawy's [1992] anytime deduction system, and with a probabilistic database model.

FOCUSING LIGHT INTO A MULTIPLE-CORE FIBER: THEORY AND IMPLICATIONS FOR GROUND-BASED INTERFEROMETRY

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Abstract

We developed a variational, scalar-field treatment of the guided modes and their propagation constants for a multiple-core optical fiber consisting of many single-mode single fiber cores closely spaced inside a common cladding material. The variational procedure, when supplemented with symmetry considerations, produced without great effort the modes and their wavevectors for a highly symmetrical arrangement of an arbitrary number of cores. By employing these modes, we computed an expression for the coupling efficiency of an arbitrary wavefront focused into such a fiber. We argue that such a fiber should be more strongly coupled than the standard single-core single-mode fiber to an arbitrary wavefront due to a piecewise coupling of the wavefront to the multiple-core fiber. The improved coupling efficiency is illustrated for a variety of turbulence-induced wavefront distortions typically seen by ground-based imaging systems. Coupling efficiency improvements by about an order of magnitude are possible under severe turbulence conditions, when compared with the performance of standard single-core single-mode fibers. Also, by making use of evanescent-field interaction among cores which causes a nontrivial evolution of core excitations and mutual coherences with propagation, one can generate sub-beams of light, one for each core, with comarable excitations and high mutual coherence. Such sub-beams from different telescopes of an interferometric array, when combined with each other, will generate fringes of high quality with rather modest co-phasing and adaptive corrections. Furthermore, the MC fiber design is rather insensitive to the conditions of turbulence, which makes MC-fiber couplers very attractive for ground-based interferometry.

STATIC AND DYNAMIC GRAPH EMBEDDING FOR PARALLEL PROGRAMMING

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Abstract

Many problems in computational physics can be modeled as a computation on a graph or network, for example, particle-in-cell plasma simulations. Solving these problems on a massively parallel processor is becoming increasingly important. As many parallel processors can also be modeled as graphs, this gives rise to the problem of efficiently embedding the "computation" graph into the "processor" graph. We survey some of the work done in this area.

For best performance, this "static" embedding must be supplemented by a dynamic re-embedding (or load balancing) as load in a time shared parallel processor varies, or the amount of computation to be done at each vertex of the computation graph changes. (The latter is a particular concern in PIC plasma simulations.) We give a new algorithm for this re-embedding based on network flows, and discuss an implementation of this algorithm and preliminary results from a simulated problem on real parallel hardware.

THE ROLE OF EXPERIENCE IN TRAINING EFFECTIVENESS

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Abstract

For a training program to be effective. trainees must not only master the trained material but also transfer their learning back to the work environment. Research suggests that one factor which can affect a trainee's ability to maintain or improve upon their level of performance acquired during training is the extent to which they get opportunities to performed the trained tasks on the job. More experience with trained tasks is likely to lead to greater skill maintenance and generalization. This study examined the role of experience in training effectiveness by reviewing the existing literature regarding the relationship between experience and performance. In addition, a meta-analysis of the study results was conducted in order to assess the extent to which the results vary as a function of other study characteristics (e.g., measurement of experience, level of analysis, criteria). Finally, implications for training effectiveness research and practice are discussed.

A HYBRID ALGEBRAIC EQUATIONS OF MOTION - NEURAL ESTIMATOR TO IMPLEMENT THE DIRECT CONTROL METHOD

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Abstract

The study of dynamic systems without resorting to or any knowledge of differential equations is known as the "Direct Method". In this method, algebraic equations of motion describe the system. By this approach algebraic optimal control laws can be derived in explicit form for general nonlinear time-variant and time-invariant systems by minimizing an algebraic performance measure. The essence of the approach is based on using assumed-time-modes expansions of generalized coordinates and inputs in conjunction with the variational work-energy principles that govern the physical system. The algebraic optimal control laws obtained by the Direct Method are in the form of digitally implementable generalized algebraic state feedback; to implement these control laws an algebraic state estimator must be designed. The development of such an estimator is presented by utilizing neural networks within a hybrid algebraic equations of motion-neural structure for general nonlinear systems. However, due to time constraints, computer simulations of the application of the method are presented for linear systems under deterministic, noisy and modelling uncertainty cases. As modelling uncertainty, both parameter uncertainty and model truncation have been considered. Beyond state estimation, the approach and the concepts presented in this report also form a framework for system identification via the hybrid Algebraic Equations of Motion-Neural network architecture. Extension of the method to nonlinear systems is straightforward and is left as a future endeavor.

A STUDY ON VIRTUAL MANUFACTURING

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Abstract

Emerging defense acquisition strategies require the capability to prove the manufacturability and affordability of new weapons systems prior to the commitment of large production resources and/or to shelving the system for restart in potential future threats. Loosing the manufacturing capability and experience in an era of "near zero" production is a major risk in the current defense environment. Maintaining the state-of-the-art manufacturing proficiency without actually building/manufacturing the weapons systems is a major challenge. Virtual Manufacturing (VM) meets the above challenges by providing the capability, in essence, to continue manufacturing in the virtual world of the computer. Through the use of distributed manufacturing modeling and simulation, VM enables the enterprises to evaluate the producibility and affordability of new product and/or process concepts with respect to risks, their impacts on manufacturing capabilities, production capacity, and cost. VM can also provide accurate and realistic means to predict schedule, cost, and quality; address affordability as an iterative solution; and bridge the gap between engineering (design) and manufacturing in an interactive fashion.

In this paper, a review of literature, the basic concepts, tools required, application areas, and the future of virtual manufacturing are presented. The actions necessary to implement and incorporate VM into the business processes are identified. Also, the benefits, costs, limitations, and risks associated with adopting VM are highlighted.

ANNEALED PROTON EXCHANGED (APE) WAVEGUIDES in $LiTaO_3$ for DIFFERENCE-FREQUENCY GENERATION of INFRARED COHERENT RADIATION

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Abstract

Annealed proton-exchanged channel waveguides in lithium tantalate were investigated. Theoretical modeling was based on the results of experimental studies performed by using a white-light source technique. Parameters defining the reconstructed profiles were evaluated by matching computed and measured values of the channel widths defining the region of single-mode operation. The calculated modal fields are in agreement with those obtained from near-field measurements.

On the Constitutive Behavior of Solid Propellants

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Abstract

The constitutive behavior of solid propellants was studied. The materials are traditionally considered to be viscoelastic, with either linear or nonlinear models being used. A number of such models exist in the literature. In the present work, experiments were performed on a composite propellant to examine the mechanical behavior in detail and to compare the validity of the various models. Uniaxial tensile tests were performed at strain rates varying from 2×10^{-3} to 10^{3} per min; relaxation tests were performed with strain levels from 4 to 20%; finally load-relax-unload and load-unload experiments were performed over a wide range of strain rates, strain levels and relaxation times. This large data set was all obtained from one batch of solid propellant. The results are reported here in detail with some preliminary interpretations in terms of the models. A detailed examination of the various models is being pursued and will be reported elsewhere.

Superresolution of Passive Millimeter-Wave Imaging

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Abstract

Passive millimeter-wave (PMMW) imagery has tremendous potential for imaging in adverse conditions; however, poor resolution poses a serious limitation to this potential. This project investigated the potential of various image acquisition and image processing strategies to superresolve PMMW images. Experimental results indicate that image processing alone cannot significantly superresolve general extended targets beyond the measured spatial frequency region. Furthermore, synthetic aperture acquisition techniques were found to be inappropriate in this setting.

A combination of acquisition strategies and image processing techniques holds the best promise for superresolution. We found that by designing the aperture weighting appropriately, one can make the acquired data more amenable to superresolution via image restoration techniques. In addition, we proposed a new acquisition method that allows one to increase the measured spatial frequency bandwidth in the data, which allows one to image beyond the diffraction limit. With these strategies, one should be able to improve resolution by a factor of three to four.

ULTRAFAST SPECTROSCOPY OF QUANTUM HETEROSTRUCTURES FOR HIGH-SPEED OPTOELECTRONIC SWITCHING

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Abstract

We have studied the ultrafast optical switching dynamics of type-II GaAs/AlAs superlattices, InGaAs asymmetric-coupled-quantum well (ACQW) materials and GaAs/AlGaAs vertical-cavity surface-emitting laser (VCSEL) structures, with an eye towards the development of high-speed optoelectronic modulators having unique operational advantages over current designs. To determine the absorption and refractive-index dynamics of these materials and to optimize device designs utilizing them, a flexible pump-probe characterization facility with femtosecond resolution in the visible, near IR, and 1.3-1.55 μm ranges is required. In this report we summarize our efforts to design and construct a suitable femtosecond pump-probe system, and outline preliminary attempts to exploit ultrafast switching mechanisms in type-II, ACQW and VCSEL materials for optical processing applications.

SYNTHESIS AND PROPERTIES OF β-DIKETONATE-MODIFIED HETEROBIMETALLIC ALKOXIDES

(Single-Source MOCVD Precursors)

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Abstract

A study was initiated to investigate both the synthetic chemistry and properties of β-diketonate-modified heterobimetallic alkoxides of the alkaline earths and titanium. A number of single metal diketonates have been utilized as source compounds in the MOCVD processing of electronic oxides (e.g., $BaTiO_3$, $YBa_2Cu_3O_x$, $Pb(Zr,Ti)O_3$, etc.). It was proposed to extend this work by conducting an initial screening study to evaluate if such chelating and branching ligand systems may be used to develop new "single-source" compounds for bimetallic oxides (e.g., $BaTiO_3$). The synthesis and properties of a 2,2,6,6-tetramethyl-3,5-heptanedionate (thd) modified barium-titanium isopropoxide was specifically studied. The results of this initial study were inconclusive, but do provide a technological justification for further study.

EVALUATION OF NETWORK ROUTERS IN REAL–TIME PARALLEL COMPUTERS

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Abstract

Although general–purpose parallel processing research has been extremely vigorous over the last few years, real–time parallel processing has not received reciprocal attention. The two fields have some commonalities but the differences are many and significant. The unique requirements of real–time applications and the resultant ramifications on real–time parallel computers should be addressed in an adequate fashion. Like general–purpose parallel processing, a real–time parallel computer is as good as its communication capabilities. The crux of the communication potential lies in the underlying communication network and the router architecture.

Unlike the conventional parallel computers, little attention has been paid to the unique problem of efficient communication in real–time, application–specific, hard deadline parallel computers. These real–time applications contribute the added complications of *when* a task is completed and ultra–dependability in addition to the need of fast execution. Fast, predictable, schedulable, and dependable communication in real–time systems can be achieved by considering the various aspects of network characteristics, topology, switching methods, and router hardware *together* and study the interplay between them. The purpose of the research reported here is to evaluate a set of communication characteristics that are deemed desirable for real–time parallel processors with respect to performance and implementation cost.

A candidate network function is accurately defined and this characterization is detailed enough to be simulated. A concise, time–driven, flit–based, priority–driven, wormhole–routed, network simulator has been designed in C with a user–friendly Graphical User Interface (GUI). The network in general and the router in particular are simulated in great detail. Experimentation is performed by monitoring the latency and the throughput with variations in different parameters including the number and width of virtual channels, number of priority levels, maximum message length, load factor, and network size. Initially the destination address, message length and message priority are generated randomly with a uniform distribution. Then, various non–uniformities are introduced to mimic realistic applications. Results are plotted and analyzed.

PHOTOREFRACTIVE DEVELOPMENT AND APPLICATIONS OF InP AND BSO

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Abstract

An investigation into the photorefractive properties of InP was initiated. Experimental apparatus for carrying out an investigation was built at Hanscom Air Force Base using a c. w. YAG laser for steady-state measurements while complimentary apparatus was built at the University of Arkansas using a picosecond tunable Ti-Sapphire laser for transient studies. Initial measurements on both energy exchange and diffraction efficiency were made indicating a high potential for InP as a photorefractor in the near infrared. Results also indicate that the photorefractive effect will be an effective diagnostic tool for characterization of InP. Because of this potential the collaboration between Arkansas and Hanscom will continue beyond the summer program period.

CHARACTERIZATION OF POLAR PATCHES: COMPARISON OF MULTIPLE SENSORS

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Abstract

Polar patches are relatively intense ionospheric structures formed on the day side of the high latitude polar region and transported across the polar cap in the anti-sunward direction towards the nighttime auroral oval. The basics of these patches has been known for some time, initially characterized using vertical ionosondes. More extensive investigations into the character of the three dimensional structure of these patches required more sophisticated systems such as the incoherent scatter radar that can scan through the patches and optical systems that photograph the entire sky from horizon to horizon at a wavelegth that distinguished the patches from the less intense background emissions. To be able to continue these investigations at locations where no radar is available is the goal of this project. Modern digital HF sounders, besides measuring the vertical electron density profile, can also detect and determine the location of small scale ionospheric irregularities which in turn map the overall structure of the large scale patches. This study demonstrates the capabilities of these HF sounders.

TURBINE BLADE FILM JET COOLING WITH FREE STREAM TURBULENCE

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ABSTRACT

Experimental measurements and closed form analytical predictions are presented for the spread and mixing of a film cooling jet injected into a high free stream turbulence main stream. Blowing ratios near one were studied at free stream turbulence levels from 0.9% to 17%. With 17 percent turbulence the spreading rate of the coolant fluid is doubled and the peak temperature difference is reduced to one fourth of the low free stream values by 15 jet diameters downstream. The experimental protion of this work was done primarily by Captain Jeffrey P. Bons of the Aero Propulsion and Power Directorate, Wright Laboratory, WPAFB.

Design of Soot Capturing Sampling Probe

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Abstract

Extractive gas sampling probes have been used for many years to acquire samples of process streams, of atmospheric aerosols, and of effluent streams from power generation and chemical process industry plants, for chemical and particulate analyses. The design and application of these probes to extract samples from rocket exhaust streams is complicated by the high temperature of the exhaust and by the fact that the exhaust flow is supersonic, which means that a bow shock wave can be formed standing in front of the probe inlet tip. Bow shock waves are strong compression waves that can raise the static temperature and pressure of the sampled gas stream, thus disturbing its chemical state, as well as cause the breakup of suspended particles in the captured gas stream, thus changing the particle size distribution in the captured sample stream.

The purpose of the task undertaken during the summer faculty research program was to develop a concept and a potential design for an extractive gas and soot particle sampling probe (GSSP) to capture soot-containing exhaust gas samples from supersonic exhaust flows of liquid hydrocarbon-fueled rocket engines. The design of the probe must minimize the effects of the sample extraction process on the chemistry of the gas and soot particles extracted, as well as minimize the effects of the sampling procedure on the soot particle size distribution. The GSSP must survive the severe thermal environment, and if possible, not create too big a disturbance in the rocket exhaust flow.

Neural Network Identification and Control in Metal Forging

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Abstract

Forged metal is used as a strengthening technique to form parts for a wide variety of applications. Currently, many aspects of the forging process are imprecise and/or ad hoc. Thus, the metal forging area is ripe for the application of process control techniques to improve the forging process for efficient and effective manufacturing.

There have been some attempts to apply control techniques to forging in the past. Most of these involve using open loop control. This report describes the application of neural network identification and feedback control techniques to some metal forging processes.

MULTIPLE JET MIXING AND ATOMIZATION IN REACTING AND NONREACTING FLOWS

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Abstract

The use of smaller multiple jets instead of a large single jet to promote mixing and atomization for gas turbine combustor applications is investigated. The mixing characteristics using different orifice patterns in a circular configuration are characterized using three different techniques; Reactive Mie Scattering (RMS), preformed Al_2O_3 seeds, and acetone based Laser Induced Fluorescence (LIF). The spray was characterized by light sheet visualizations where the spray was introduced at the center of the circular orifice pattern issuing dry air. The air jets and spray behave as an air blast atomizer, seven different orifice configurations were assessed. Two different liquids were used for the cold spray visualizations, water and stoddard solvent. It was observed that the stoddard solvent best resembled the atomization characteristics of JP8 plus 100 as compared to water. The air blast atomizers were also tested in a single dome combustor, where the multiple jets were introduced in the liner wall 45 mm downstream of the center dome. A single 1/2" orifice jet was positioned opposite the multiple jet forming an opposed jet configuration 45 mm downstream of the dome. Only the top multiple jet and the dome contained fuel. The inlet air temperature was 500 °F for the side jets and dome. The side jet injection using fuel and air created a more stable combustor, the lean blowout was decreased by 50%. This preliminary investigation of side fuel injection shows promise for better combustion efficiencies and possible pollutant reduction.

SEQUENTIAL ESTIMATION OF PARAMETERS OF TRUNCATION PARAMETER FAMILIES

AND

HALF-LIFE STUDIES IN RANCH HAND VETERANS

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Abstract

In the first part of this study, we considered a one truncation parameter family of distributions with pdf of the form $f(x;\theta)=q(\theta)h(x)$, $a<x<\theta$. We studied the sequential estimation of a function of the unknown parameter under type II censoring. The stopping rule is derived in a manner to minimize the total of the risk plus the cost of sampling. We showed that the sequential estimator is asymptotically unbiased. Also, we proved that when $b>0$, the stopping rule terminates finitely with probability one. Moreover, it is also shown that the stopping rule is asymptotically efficient and risk efficient as b tends to zero.

In the second part of this study, we found a new half-life of dioxin concentration in Ranch Hand veterans. First, we estimated the regression effect on decay rate, and then calculated the corrected half-life using the regression effect. Using 1982 and 1987 dioxin concentrations the corrected half-life was found to be 9.0 years, and using 1987 and 1992 dioxin concentrations it was found to be 7.3 years. Using all three points, that is 1982, 1989 and 1992 dioxin concentrations, the half-life was estimated as 7.77 years.

MULTISITE OPTICAL RECORDING OF EVOKED ACTIVITY IN MOUSE SUPRACHIASMATIC NUCLEI

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Abstract

Fast multisite optical recording techniques were used to monitor activity in mouse suprachiasmatic nuclei (SCN) evoked by direct electrical stimulation of the SCN tissue with a focal electrode. Experiments were performed on coronal brain slices (400-500 μm thick) obtained from an inbred mouse strain (C57BL/6NHsd). Under normal conditions, the amplitude of optically recorded signals evoked by focal electrical stimulation was found to be quite small. Signal size was not significantly improved by $GABA_A$ receptor blockade with picrotoxin. A large increase in signal size was observed, however, following bath application of the potassium channel blocker, 4-aminopyridine (4-AP). In slices treated with 4-AP, focal stimulation generated electrical activity that propagated medially into the contralateral SCN and dorsally into an area ventral to the paraventricular nucleus of the hypothalamus (PVN) known as the subperiventricular region. Propagated activity could be abolished by the voltage-sensitive sodium channel blocker, tetrodotoxin, indicating that is was being conducted by nerve action potentials in axonal fibers. Although it seems likely that most, if not all, of these axonal fibers arose from SCN efferents, activity in retinohypothalamic fibers could not be ruled out in the current series of experiments. The significance of these finding for future investigations of the SCN efferent system is discussed.

LINKING LABORATORY RESEARCH AND FIELD APPLICATIONS OF COMPLEX SKILL ACQUISITION

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Abstract

Data were analyzed and articles were prepared for three laboratory studies that were designed to represent complex skills learned in military and industrial settings. Effects of competition, spacing of practice, and gender, were investigated. In addition, a theoretical article was prepared to discuss the implication of this and other recent research for expanding the role of skill acquisition specialists in the evolution of effective human-interfaced systems.

A STUDY OF ACTIVE CONSTRAINED LAYER DAMPING TREATMENTS ON COMPOSITE BEAMS

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Abstract

This research has two objectives. The first objective is to develop a mathematical model to predict bending, twisting, and axial vibration response of a composite beam with active constrained layer (ACL) or intelligetn constrained layer (ICL) damping treatments. The second objective is to verify the concept of active constrained layer through laboratory experiments and to evaluate the strength and weakness of this new technique.

To achieve the first objective, an ICL composite beam model is obtained by integrating the existing ICL composite plate model proposed by Shen (1994a). When the plate width (along the x-axis) is much smaller than the plate length (along the y-axis), integration of the ICL composite plate equations and linearization of displacement fields with respect to x will lead to a set of equations that couples bending, tosional, and axial vibrations of a composite beam. The equations of motion and associated boundary conditions are normalized and rearranged in a state-space matrix form, and the vibration response is predicted through the transfer function approach developed by Yang and Tan (1992). A numerical example is illustrated on a composite beam with bending-torsion coupling stiffness. Numerical results show that ICL damping treatments may or may not reduce coupled bending and torsional vibrations of a composite beam simultaneously. When the deflection is fed back to actuate the ICL damping treatment, a sensitivity analysis shows that only those vibration modes with significant bending response will be suppressed simultaneously with their torsional components.

To achieve the second objective, two different ICL setups are tested on a composite beam without bending-torsion coupling. Damping performance of both ICL setups agree qualitatively with existing mathematical models and experimental results obtained from other researchs. The damping performance, however, is not optimized due to the availability of materials and their dimensions in the laboratory. An optimization strategy needs to be developed to facilitate design of ACL damping treatments with maximized damping performance.

A MODEL FOR LOCAL HEAT TRANSFER AND ICE ACCREATION IN HIGH SPEED SUBSONIC FLOW OVER AN AIRFOIL

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Abstract

Icing occurs on the forward-facing surfaces of aircraft when they encounter clouds of supercooled water droplets. The rate and nature of the ice accreting on the surface are functions of the flight speed and altitude, aircraft configuration, cloud liquid water content, water droplet size and distribution, and ambient temperature. Icing clouds can either be stratus or cumulus. The former type has a large horizontal extent and depth, a moderate liquid water content, and an altitude of 5,000 ft. Cumulus clouds, on the other hand, have a small horizontal extent, a large liquid water content, and an altitude of 10,000 ft. Temperature and droplet size are similar for both types of clouds, however.

The object of this research effort is to develop a semi-empirical model for determining the local heat transfer and ice accretion rates on the surface of an airfoil under a host of scenarios that involve changing the flight speed and altitude, cloud liquid water content, water droplet size and distribution and ambient temperature. The model is general enough to handle both the leading edge and aft regions of the airfoil under laminar and turbulent flow conditions. The model is also capable of handling conditions that involve equilibrium surface temperatures near the freezing point so that freezing, condensation, sublimation, and evaporation can occur simultaneously.

USING THE SEM-EDXA SYSTEM
AT AL/OEA FOR ANALYSES OF AIRBORNE FIBERS
AND DENTAL WATER LINES

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ABSTRACT

The health hazard posed by airborne asbestos fibers is well documented. Numerous analytical methods for their identification and characterization have been published but analytical procedures for other fibers are not as well defined. This project involved using the Amray 1820 Scanning Electron Microscope equipped with an Electron Dispersed X-ray Analyzer to overcome this deficiency in the asbestos analysis section at the Armstrong Laboratory.

During previous tenures at AL/OEA, the author and his colleagues produced data for a number of standard fibers and established a basic fiber/mineral identification library. From the elemental analyses and cation/anion ratios, they succeeded in characterizing most fibers or minerals, which were submitted to the laboratory.

During the current fellowship the library was expanded and modified, not only for fiber/mineral identification, but also to demonstrate the analytical prowess of the SEM-EDXA equipment for analyzing non-routine samples. Over 100 samples were characterized. A great deal of effort was devoted to determine the biological and chemical buildup in dental water lines in conjunction with the Dental Investigations, AL/AOCD.

Frequency Domain Analysis Of Short Exposure, Photon-Limited Astronomical Data

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Abstract

Obtaining high resolution images of objects in space is a common subject in research today. Turbulence in the atmosphere limits the image resolution obtained with larger telescopes. To combat this atmospheric effect, speckle imaging techniques have been developed that average out atmospheric turbulence to improve image resolution. The performance of these techniques is limited by the achievable signal-to-noise ratios (SNR) in the data. Our aim is to use experimental data to test theories on the effect of spectral bandwidths on the data SNR. In addition, we use experimental data to determine the Fourier domain noise characteristics of the processed data. These results will be used to determine the usefulness of prior knowledge for noise reduction.

TOPAZ II REACTOR CONTROL LAW IMPROVEMENT

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Abstract

The 6 kW_e space nuclear reactor power system TOPAZ II that generates electricity from nuclear heat using in-core thermionic converters is considered. The major subsystems that comprise the power system are: the nuclear reactor, which contains the thermionic converters, the radiation shield, the reactor coolant system, the cesium supply system, the instrumentation and automatic control system. The TOPAZ II Automatic Control System is mainly designed to start up the TOPAZ II system, to control the reactor thermal and electric power being supplied to the spacecraft payload and to shut down the TOPAZ II system.

The control algorithms of the TOPAZ II system has been improved to meet the following main goal. This is *to ensure the reduced sensitivity of the reactor thermal and electric power control processes to the system parameter uncertainties mostly associated with the neutron detectors ("ionization chambers") and external disturbances while providing the reference electric or thermal power profile following.*

The enhanced controllers have been designed via implementation of the sliding mode control technique which is very helpful in the controller design upon the uncertain environment. The TOPAZ II Automatic Control System with the designed sliding mode controllers has been simulated in the start up mode and the electric power (current) profile following mode. The result of simulations showed the reduced sensitivity of the control processes to the variation of the parameters of the system and the improved accuracy and robustness of the thermal and electric power (current) reference profile following. The realization of the designed sliding mode controllers in the TOPAZ II Automatic Control System

- should improve the accuracy of the system performance,
- should bring more reliability and flexibility to the TOPAZ II operation.

HRR Radar Based Target Identification

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Abstract

A high range resolution radar sensor is under investigation for an automatic target identification system. In this report, a model for the return signal is formulated and applied to stretch-radar processing. For point scatterers this leads to a sum of sinusoids plus noise model and so spectral estimation techniques may be employed to extract low dimension feature vectors that can be subsequently applied to a feature classifier. An approach to the optimal design of classifier is outlined and a procedure for template generation is proposed. Experimental results on characterizing the radar signatures using spectral estimation techniques is presented. Linear and quadratic classifiers using range profiles as the feature vectors are also implemented.

DOCUMENTATION OF BOUNDARY LAYER CHARACTERISTICS FOR LOW CHORD-REYNOLDS-NUMBER FLOW ON THE SUCTION SURFACE OF A LOW-PRESSURE TURBINE AIRFOIL

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Abstract

It is recognized that the low-pressure turbine has, because of its low chord Reynolds number, regions of strong acceleration and diffusion effects. Consequently, there are extended regions of transition from laminar to turbulent flow and there is a strong likelihood of having regions of flow separation. To investigate this low-Reynolds number flow, a program was initiated where a representative low-pressure turbine airfoil configuration is installed in a wind tunnel facility and run at chord Reynolds numbers of 40,000 and 80,000. High background turbulence and disturbances from passing wakes are imposed upon the flow to simulate the turbine environment. The boundary layer state, laminar-like or turbulent, separated or attached, is characterized for representative operating conditions. Instrumentation includes hot-wire anemometry and surface-mounted thin film sensors. When without wake passing disturbances, surface static pressure taps are used to document surface static pressure coefficient, Cp, distributions. With background turbulence present but without wakes, cases are run for TI levels of 1.0 and 20 % for chord Reynolds numbers of 40,000 and 80,000. These cases are repeated with wake generation at representative blade velocities. For documenting the approach flow, turbulence spectra and turbulence intensities are taken for the various TI levels and Re_C values with and without wake generation. From this, the integral length scales are computed. Measurements within the cascade include, on the suction surface, the transition location, the separation location, and the point of reattachment. Instruments for locating these regions are surface-mounted thin-film gages and a hot-wire sensor positioned very near the wall at various streamwise locations. To document the statistical quantities when operating with wake generation, rms fluctuation levels of an ensemble of records are taken behind the wakes and between the airfoils. They are encoded off the translation device and plotted versus t/τ (the dimensionless time within the wake passing period). These data are used to characterize the unsteadiness.

MECHANISM FOR INDIUM SEGREGATION

IN $In_xGa_{1-x}As$ STRAINED QUANTUM WELLS DURING MBE GROWTH

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ABSTRACT

Indium surface segregation was investigated during deposition of $In_{0.22}Ga_{0.78}As$ strained quantum wells on GaAs by Molecular Beam Epitaxy. The indium concentration profiles have been studied by Desorption Mass Spectrometry and amount of surface indium was assessed by Reflection High Energy Electron Diffraction. In particular, the In profiles in as-grown and in situ annealed strained layers have been studied. The analysis of results led us to propose a new mechanism for surface segregation, namely that of solid state diffusion enhanced by high concentrations of cation vacancies in the subsurface region with thickness of approximately 8 monolayers. Consequences of the proposed model for deposition of square InGaAs quantum wells will be discussed.

QFT CONTROL OF AN ADVANCED TACTICAL FIGHTER
AEROELASTIC MODEL

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Abstract

This report discusses Quantitative Feedback Control (QFT) of an aeroelastic model typical of advanced tactical fighter aircraft. The aeroelastic model is high order, unstable, and nonminimum-phase. Control is attempted on the original plant, the partially dynamically inverted plant, and the dynamically inverted plant. Application of the Nyquist stability criterion using Nichols plots is discussed and suggestions for future efforts are given.

The TkWWW Robot: Beyond Browsing

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Abstract

The TkWWW Robot extends the functionality of the TkWWW browser. It can also be used as a standalone agent that processes queries on the WWW. In either case, the robot traverses the web according to functions described using Tcl extensions developed for the TkWWW browser and the TkWWW robot. Tcl language extensions allow novice users to direct a search based on key words and HTML data types or to invoke predefined queries. Expert users can add their own Tcl extensions for use in more sophisticated searches. The system can be quickly adapted to support new resource types that may become available on the WWW, such as live audio/video connections for interaction with experts.

When TkWWW robots are dispatched from the TkWWW browser, their results can be used to guide further browsing. Robots can also be run in the background to build HTML indexes, compile WWW statistics, collect a portfolios of pictures, or perform any other function that can be described by the TkWWW Tcl extensions. Searches can be restricted according to URL names, limits on search path lengths, etc. The TkWWW robot can interact with its master by popping up windows to request input according to a Tcl query description. The main advantage that the TkWWW robot has over existing web spiders and robots is its flexibility in adapting to virtually any criteria possible to guide its search path and control selection of data for retrieval.

The paper presents the architecture and implementation of the TkWWW robot. It describes Tcl extensions implemented to support TkWWW robot queries. The TkWWW Robot is being developed over the summer at the Air Force Rome Laboratory with funding from the Air Force Office of Scientific Research.

AETMS: Analysis, Design and Development

R. Ramesh

Associate Professor

1 Introduction

The development and maintenance of all aircrews and support personnel in a state of mission-readiness is a primary goal of the Air Force. The training of all air staff is systematically carried out at both formal training schools and the field units of the Air Force to meet this objective. The formal training broadly consists of primary air education for all aircrew and support personnel, undergraduate aircrew training, graduate level combat crew training, technical training for the maintenance personnel and continuation training for all air staff. In 1993, all formal training programs have been consolidated and integrated under the Air Education and Training Command (AETC) of the Air Force. AETC is headquartered at Randolph AFB and its training programs are broadly organized into the Air University, 19^{th} Air Force and 2^{nd} Air Force. The Air University is responsible for primary air education and is headquartered at Maxwell AFB. The 19^{th} Air Force operates from Randolph AFB and is responsible for all aircrew training. The 2^{nd} Air Force operates from Keesler AFB and is responsible for all technical training. The training wings under each of these units are located at various bases and conduct both initial and continuation training.

CHARGE TRANSPORT AND SECOND HARMONIC GENERATION IN GLASS WAVEGUIDES

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Abstract

Second harmonic generation of laser light in glass films was studied. Laser light from a Nd:YAG ($\lambda = 1.06\,\mu m$) laser was coupled into a 2µm thick glass film. Second harmonic signal was detected when either an external electric field was applied across the waveguide, or when the film was seeded with second harmonic light overlapping the fundamental radiation. Experimental results demonstrate that when an external field is applied, the second harmonic signal is proportional to the square of the applied field. However, this signal decays to some steady state value, indicating a screening of the applied field within the waveguide. When second harmonic signal is film generated, the growth of the signal can be slow, and in some cases oscillatory. It has been proposed that this growth is the result of an asymmetric current within the film. Modeling of charge transport within glass films suggest that when the carrier lifetime is longer than the diffusion time, oscillations in the film generated dc field, hence in the second harmonic signal, can be expected.

IMPEDANCES OF COPLANAR CONICAL PLATES IN A UNIFORM DIELECTRIC LENS AND MATCHING CONICAL PLATES FOR FEEDING A PARABOLOIDAL REFLECTOR

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Abstract

In this paper we investigate impedance characteristics of coplanar conical plate geometries which pass through a lens boundary. The plates are initially in a dielectric lens matching to exterior conical plates which serve as a paraboloidal reflector feed. The lens impedance Z_{in}, is a function of the "half-angle", α', of the interior conical plates, but is independent of the ratio, F/D, of focal length to reflector diameter. Various practical choices of this ratio are made and impedances, Z_{out}, of the exterior region are calculated. As $\alpha' \longrightarrow 0$, the ratio Z_{out}/Z_{in} approaches $\sqrt{\epsilon_r}$, where ϵ_r is the relative permittivity of the lens region. As α' increases, the impedance ratio also increases. Numerical and graphical impedance results are presented as a function of F/D, so that one can trade off the various performance characteristics.

Reflected Laser Communication Systems

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ABSTRACT

Under the AFOSR summer research program researchers from Utah State University / Space Dynamics Lab spent 12 weeks at the Phillips lab developing the reflected laser communication concept for low Earth orbiting satellites. The work was divided into proof of concept studies, technical demonstrations, and organization of a future cooperative research. The bench testing of a ferroelectric liquid crystal based retromodulator indicated that bandwidths on the order of 50 kHz can be achieved with off the shelf components. A proof of concept study using a high altitude balloon has been organized to further test the ferroelectric liquid crystal based retromodulator design of Utah State. This report outlines some of the reflected laser communications activities conducted under this summer research program.

REGIONAL ARTERIAL COMPLIANCE AND RESISTANCE CHANGES FOR TRANSIENT +Gz PROFILES

Richard D. Swope

ABSTRACT

The primary aim of this research is to determine regional variations in peripheral resistance, blood volume and arterial compliance caused by transient +Gz loads. A model previously used to analyze systemic arterial compliance and total peripheral resistance is extended to allow similar calculations for the head, lungs and body as well as shifts in blood volume between these regions. Gravitational loss of consciousness (G-LOC) is a direct result of a prolonged blood volume shift from the head to the body and the new model allows a study of the relationship between this shift and regional changes in resistance and compliance on a beat to beat basis. Practical surgical limitations require the development of a new transducer for measuring pressure and flow in the pulmonary artery and the aorta before the method can be implemented. Preliminary work with a modified transit time ultrasonic transducer shows promise as a solution to this problem.

DIMENSIONAL ANALYSIS OF ARC HEATERS

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Abstract

A predictive equation for the operation of arc heaters was developed using non-dimensional Pi parameters. It was shown that the gross efficiency of a heater can be expressed in terms of heater length, its throat diameter, and the effective length of the air column heated by the arc's discharge path. This together with non-dimensional expressions for sonic flow and centerline enthalpy allows us to predict the voltage and the current necessary to operate a heater at a given pressure and desired heat output.

PERFORMANCE ANALYSIS OF QUADRATIC CLASSIFIERS FOR SYNTHETIC APERTURE RADAR TARGET RECOGNITION

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Abstract

We study the performance of quadratic pattern classification algorithms as applied to a prototype problem in automatic target recognition. We generated synthetic aperture radar images of four vehicles using the Xpatch electromagnetic scattering code and a SAR image formation algorithm. Each class contained eleven images of the target appearing at slightly different azimuths with respect to a fixed reference direction. We used the images to train a quadratic classifier algorithm, and we evaluated its performance when a test image was distorted by random pixel fluctuations. Several variations of the quadratic classifier were tested. We compare their performance against one another. We found that an adaptive gain factor, used to scale the test images before classification, improved the classifier's performance significantly.

ULTRAVIOLET FLAT-FIELD RESPONSE OF AN INTENSIFIED CHARGE-COUPLED DEVICE (ICCD) CAMERA TO NANOSECOND LASER PULSES

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ABSTRACT

The flat-field response of an intensified charge-coupled device (ICCD) camera to ultra-violet (uv) pulses from a Nd:YAG/dye laser system was determined. Intensifier gate-widths ranged from 50 ns to 200 us. The flat-field illumination was obtained in two different manners: 1) nitric oxide (NO) fluorescence from a static cell, and 2) fluorescence output from an integrating sphere. A third method, steady-state illumination of a diffusion screen with a deuterium lamp, was used to obtain a comparison of steady-state versus pulse illumination response. Measurements were obtained on two essentially identical camera systems; these cameras are to be used for dual-wavelength planar laser-induced fluorescence (PLIF) measurements of shock flows. Such measurements will allow temperature visualization within the flow. Results indicate that both camera systems have a non-linear signal versus energy response; the response is stable and can be corrected. A linear correction can be used for signals below 20% of the maximum camera response. There is also a smooth, correctable variation of response across the 578x384-pixel image. Corrected images are flat to within 10% or better.

ELECTROLUMINESCENCE STUDIES OF THE RIGID ROD POLYMER

Poly (p-phenylenebenzobisthiazole) (PBZT)

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Abstract

Poly (p-phenylenebenzobisthiazole)(PBZT) is a rigid rod polymer with excellent thermal and mechanical properties. Electroluminescent devices with PBZT as the active layer were fabricated upon an indium-tin oxide (ITO) coated glass slides. Magnesium metal was evaporated as the injection electrode, and the magnesium was overcoated with an evaporated silver layer to reduce oxidation of the magnesium. The devices were characterized using current-voltage and spectral techniques. The current-voltage measurements indicated that the devices acted as a diode with a significant resistive component; while the spectral studies showed an emission from 850 nm (the long wavelength limit of the apparatus) up through about 525 (nm) at device voltages ranging from 2.35 V to 4.0 V for various devices studied. The light output of the devices decreased with usage until the device ultimately failed. The devices also became more resistor like with use until failure occurred.

A MATHEMATICAL MODEL OF SELF COMPRESSION OF COMPACT TOROIDS

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Abstract

A mathematical model using a lumped parameter approach is developed in a systematic and rigorous manner to study the self similar compression of compact toroids (CT) in a coaxial and conical railgun.The CT is modelled as a ring with annular spherical caps as its bottom and top boundaries orthogonal to the radius vector rather than planar boundaries orthogonal to the z-axis. The ring element is endowed with the appropriate internal plasma flow with both radial and azimuthal kinetic energy and momentum. It is further endowed with an appropriate internal energy and a magnetic field. The presence of an initial magnetic field, an internal energy and rotational kinetic energy have immense effects on the compression dynamics of the CT. These effects are rigorously modelled and studied with respect to the stagnation points at which the maximum radial convergence of the CT is obtained under a particular set of operating conditions. We found that the effective inductance gradient of the accelerator, L', is sensitive to the precise shape of the drive current. In the present paper, the drive current is assumed to flow in the q-direction along the upper spherical cap.

The development model has been very rewarding in several ways. It leads directly to closed form analytical expressions describing the physics of the CT compression explicitly in several major cases. The closed form analytical solutions are found to be very useful for studying quantitatively the details of the compression dynamics. The mathematical development leads naturally to simple computer models for simulating the operation at the system level of actual devices using realistic power supplies including capacitor banks, inductor with opening switch, and magnetic flux compression generators. This should provide a very useful aid to the engineering design of actual CT compression devices and to the interpretation of experiments.

VHDL-93 PARSER IN PROLOG

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Abstract

This report describes the upgrading of a VHDL-87 parser written in Prolog (by Peter Reintjes) to conform to the IEEE Standard 1076-1993 of VHDL. The original parser, which is based on a simplified grammar of VHDL-87 (given by Lipsett, Schaefer and Ussery), was first modified to conform to the IEEE Standard 1076-1987. Subsequently, it was extended by incorporating additional features supported by VHDL-93. The new parser has been tested on the VHDL-87 test suite and a few VHDL-93 programs. Our VHDL-93 parser takes about 30% longer to parse the VHDL-87 test suite.

DEVELOPING QUALITATIVE PROCESS CONTROL DISCOVERY SYSTEMS

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Abstract

The theory and application of artificial intelligence and qualitative process modeling methodologies were studied in the contexts of process control for automated composite materials curing and hyperbaric oxygenation. Knowledge bases, quantitative/qualitative data encoders and decoders, serial port data acquisition routines, expectation/exception handling, envisionment evaluation, and rule mutation heuristics were developed to support discovery capabilities. The principal objective was to develop a discovery system capable of controlling materials processes, recognizing sensor errors and cure exothermy, and generating new process rules based on evaluation of real experimental data against the existing knowledge base heuristics of a fundamental qualitative process model. A secondary objective was to begin the construction of a system to model and to conduct discovery for processes involved in hyperbaric wound healing. The operation of fundamental qualitative process models was demonstrated, and system heuristics were successfully created for identifying unexpected states, generating new rules, and controlling on-line process parameters.

REPRESENTING AND TEACHING A DISCRETE MACHINE: AN INSTRUCTIONAL DESIGN PROBLEM IN PROCEDURAL LEARNING

Steven D. Tripp
Assistant Professor
Department of Curriculum and Instruction
University of Kansas

Abstract

My Casio AltiDepth Watch is emblematic of a class of modern machines that we are faced with mastering. It has 51 functions controlled by four buttons. The internal operations of the watch and the pattern of button-presses are obscure to the user. Learning to operate such machines is notoriously difficult. Standard instructional design (ID) prescriptions for teaching procedures are not helpful. ID typically conceives of procedures as a single string of salient events, perhaps with decision points. The Casio watch is not a single procedure, but a set of parallel procedures, each of which is minimally different from the others. Although there is visual and auditory feedback from the display, it is not sufficient to support operation without some degree of mastery of the command language. For this project a computer-based simulator was developed and a task-action grammar (TAG) was written to represent the command interface. The simulator and TAG will be used to test hypotheses about different approaches to designing instruction for discrete machines; i.e., machines operated by buttons or keys that assume a set of discrete states.

A STUDY OF MASSIVELY PARALLEL COMPUTING ON EPIC HYDROCODE

C.T. Tsai
Associate Professor

Department of Mechanical Engineering
Florida Atlantic University

Abstract

The massively parallel computing on EPIC hydrocode was studied. In order to apply the latest massively parallel programming language (MPPL) to the EpIC hydrocode for increasing the computing speed, several key algorithms are examined for the suitability of parallelism. Those algorithms are coded and tested in both MasPar MP-1 massively parallel computer and Cray T3D Massively parallel emulator. The results show that massively parallel computer can drastically increase the computing speed over single processor computer.

AUTOMATED DETECTION OF INDIVIDUAL RESPONSE CHARACTERISTICS IN TRACKING TASKS: AN EXPLORATORY STUDY USING NEURAL NETWORKS

Ryan D. Tweney & Susan T. Chitwood
Department of Psychology
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Abstract

The possibility of detecting individual differences in a complex tracking task was examined. Tracking data from a dual task study designed to examine the effects of workload on performance was examined. Neural networks were used to characterize individual subject performances. A variety of network types and architectures were explored, in an attempt to determine: (a), whether differences in performance configuration among different subjects could be detected by the networks, and, (b), whether the networks could discriminate the specific experimental condition that a particular individual record of performance scores had been gathered in. Success in both tasks was shown to be highly dependent upon the nature of the data used for analysis. In general, networks can detect some individual characteristics from raw performance data, and, in some circumstances, may be able to characterize the external conditions that produced particular response configurations. Extensions of the present methodology to performance data gathered in real-time flight simulations thus seem potentially promising and are under consideration for future investigation.

INVESTIGATIONS OF ELECTRON INTERACTIONS WITH MOLECULES: ELECTRON ATTACHMENT AND ELECTRON DETACHMENT REACTIONS OF HALOGENATED MOLECULES

Jane M. Van Doren   Albert D. Kowalak

Introduction

The interactions of electrons with molecules play important roles in many systems including electronics, biochemistry and atmospheric chemistry. One important area of research is the investigation of reactions which chemically transform electrons to negative ions. Such reactions play central roles in the production of ions in the atmosphere, determination of the atmospheric lifetime of neutral (reactant) molecules and the evolution of natural and man-made plasmas. The Air Force research program has contributed to our understanding of many of these processes. In recent years, the Air Force emphasis has been on plasma evolution and to a lessor extent, atmospheric lifetimes of trace species.

Information on interactions between electrons and molecules is relatively scarce, reflecting the difficulty in both experimentally probing electron-molecule interactions and interpreting the results of such probes. The Flowing Afterglow Langmuir Probe (FALP) Technique is a versatile technique which allows investigation of a wide range of electron-molecule reactions at low collision energies, providing quantitative values for electron attachment rate coefficients.

A MULTIPLEXED FIBER-OPTIC LASER FLUORESCENCE SPECTROMETER FOR FATE AND TRANSPORT STUDIES OF GROUNDWATER CONTAMINANTS

Brian S. Vogt
Professor
Department of Chemistry

Abstract

Previous research efforts have resulted in a uniquely designed laser probe that has been interfaced to a column and used to monitor the flow of contaminant plumes through sand packed into the column. This report conveys the results of subsequent work, which has resulted in miniaturized laser probes with outside diameters of only 0.125 inch, a multiplexing system that connects several probes to the laser spectrometer, and computer control that automates instrument control, data acquisition, and data logging. Several recommendations were made that concerned further testing of the probes, direction for future experiments, and possible apparatus improvements. Additional personnel would also facilitate progress.

A HETEROGENEOUS PARALLEL ARCHITECTURE FOR HIGH-SPEED IMAGE PROCESSING

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Abstract

Unlike single-processor computers, parallel processing systems have not "converged" on a single architectural model. Many parallel architectures exist, representing different computational models, control schemes, memory hierarchies, and interconnection topologies. A related and recurring problem for many advanced architectures is that, for most of the applications that use them, peak performance is achieved only a fraction of the time. These effects are due in part to the diverse computational needs between different problem areas, and even within the same area. One way in which these effects can be attenuated is by taking advantage of different computational resources available, and by carefully matching algorithm segments to appropriate architectures. Heterogeneous computing is the intelligent use of diverse processing hardware to meet distinct computational needs. In this study, heterogeneous computing concepts are exploited in the development of a small parallel processing system designed to analyze image sequences. The architecture developed is an aggressively miniaturized MIMD shared-memory parallel architecture consisting of 12 TMS320C30 processors in a 3-D monolithic assembly of approximately two cubic inches. Intended for image processing applications on space-based and flyable vehicles, the architecture has a potential of 396 MFLOPS with frame rates of 200 frames/second at a resolution of 256x256 12-bit pixels.

Acknowledgments:

The following persons were instrumental in the preparation of this document and the research presented herein:

INVESTIGATION OF THE ROLE OF HAPTIC MOVEMENT IN TACTILE PATTERN PERCEPTION

Janet M. Weisenberger
Associate Professor
Department of Speech and Hearing Science
Ohio State University

Abstract

A series of experiments was conducted to investigate the role of haptic movement in the perception of complex vibratory patterns. In initial studies, results indicated that haptic movement of the display relative to the pattern to be sensed was superior to passive movement of the pattern on a stationary fingertip. In the present experiments, two further issues were addressed. First, we attempted to determine what aspects of haptic scanning might have produced superior performance. Possible candidates included the ability to repeat the stimulus under haptic scanning, and the ability to scan the stimulus from any direction, two aspects not available under the other modes. Two experiments addressed these aspects of presentation. In an experiment in which observers were permitted to repeat the stimulus under any presentation mode, results indicated that the ability to have multiple presentations of the stimulus accounted for much of the benefit provided by the haptic mode. A second experiment, in which subjects were permitted to select the direction of scanning in a passive scanning mode, revealed that certain scanning directions produced higher levels of performance, suggesting that they carried more information about stimulus features.

In a second series of studies, the question of whether the tactile "field of view" could be reduced was investigated. Reductions of the original 30-element tactile display, which covered the entire fingertip, to 9 elements, 4 elements, and 1 element were implemented, and pattern perception under haptic scanning was evaluated. Performance was unimpaired for reductions to 9 elements, and only slightly impeded by reductions to 4 elements. However, scanning with a single element was very difficult, and performance levels barely exceeded chance. Results are discussed in terms of practical development of tactile displays for telerobotics and virtual reality applications.

POLARIMETRIC RADAR SCATTERING FROM A VEGATATION CANOPY

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Abstract

Experimental measurements of the bistatic radar scattering from a wall of deciduous trees have been performed. The coherent like- and cross-polarization scattered fields were measured for both vertical and horizontal transmit polarization, allowing the calculation of the full Mueller scattering matrix. The transmitter location was fixed throughout the experiment, while the receive position was varied approximately along an arc around the illuminated section of trees. The illumination elevation angle was downward at 6 degrees while the measured receive elevation angles varied from approximately 0 degrees to 6 degrees downward.

STRESS ANALYSIS OF THE V-NOTCH (IOSIPESCU) SHEAR TEST FOR COMPOSITE MATERIALS

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University of Dayton

Abstract

Use of higher order beam theories is investigated in conjunction with stress analysis of the V-Notch Shear Test for composite materials. Higher order displacements are utilized which lead to a third order polynomial in the inplane normal stress, σ_x, relative to the thickness coordinate. Through-the-thickness shear stress, τ_{xy}, and normal stress, σ_y, are obtained by integrating the equations of classical theory of elasticity in conjunction with σ_x. Numerical results indicate that transverse normal strain, ε_y, can have a significant effect on the shear stress distribution at the notch cross-section. In addition, a singularity analysis at the notch tip is performed. No singularity was obtained for isotropic materials. However, singularities were obtained in conjunction with 0° unidirectional composites and 0°/90° laminates utilizing state-of-the-art graphite/epoxy material properties.

TRANSFERRING TECHNOLOGY VIA THE INTERNET

Rolf T. Wigand, Slawomir J. Marcinkowski and John Carlo Bertot
School of Information Studies
Syracuse University

Abstract

The current global economic climate is such that a nation acquires and maintains its wealth, prosperity, and strength predominantly through trade. It is necessary, but no longer sufficient, for a nation to possess a strong military function in a global marketplace. This new emphasis on national competitiveness in trade places Rome Laboratory, as well as other federal laboratories, at an important crossroads. On the one hand, a military advantage requires continual technological superiority. On the other hand, Rome Laboratory needs to facilitate national economic development through the transfer of its technologies into the marketplace. These developments serve to highlight the importance of a proactive technology transfer process within Rome Laboratory. However, a proactive operation is difficult to put into action without forthcoming budgetary and personpower increases. This study focuses on a low-cost alternative: to use MOSAIC on the Internet and the World Wide Web to promote the transfer and commercialization of technology. An electronic system was developed allowing access on various technology transfer information and databases to the private sector, as well as Rome Laboratory and other Air Force and public sector users. This report describes these efforts, underlying reconceptualizations, design and implications of the electronic system.

Temperature Dependence of THz Emission from <111> GaAs via Trans-Resonant Excitation

X.-C. Zhang

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Abstract

We have measured and compared the temperature dependence of THz radiation induced by ultrafast photocarrier transport and optical rectification via trans-bandgap femtosecond optical excitation from a single <111> oriented GaAs crystal. We report our extended measurement of the temperature dependence of THz emission from a single <111> oriented semi-insulating GaAs crystal under femtosecond trans-resonant optical excitation. Specifically, we report on the temperature effects in the THz radiation resulting separately from optical rectification or ultrafast photocarrier transport, as a function of the incident excitation wavelength. In particular, we observed enhanced THz emission from both radiation mechanisms when the incident excitation wavelength was tuned above the temperature dependent optical absorption bandedge.

DETERMINATION OF SPACE DEBRIS FLUX
BASED ON A FINITE MASS

Wayne J. Zimmermann
Professor
Department of Mathematics & Computer Science
Texas Woman's University

Abstract

This paper provides an overview of a problem related to space debris. It begins with a short review of the basic concepts and continues with a brief remark concerning existing models. Following this review we then present some models based on the principle that all debris consist of the material placed in orbit. Using the mass of the satellites, their associate components, the cross-sectional geometry of the selected altitude layer(s), two mass-dependent-population distributions and two altitude-dependent-population distributions the flux can be determined. The first model is based on the limited available mass, a single layer, a uniform mass distribution of the debris and the assumption that all debris is contained within the selected altitude bin. The next model removes the assumption imposed by the uniform mass distribution and replaces it with a distribution based upon current observations. It is then indicated that these models can be extended to multilayer models which can then be extended by applying two distinct altitude-dependent-population distributions. This approach defines the following four models: (1) n-layers, uniform mass distribution, uniform altitude distribution, (2) n-layers, uniform mass distribution, and an altitude distribution based on observations, (3) n-layers, an observational based mass distribution and a uniform altitude distribution, and lastly, (4) n-layers, observational based mass distribution and an observational based altitude distribution. These models ignore the inclination dependent population distribution. Inclusion of this distribution would generate four additional models.

THERMAL ANALYSIS OF HADN AND S-HAN5

Christopher D. Amos
Desert High School

Abstract

The thermal properties of HADN and S-HAN5 and their mixtures were studied. Using the method of differential scanning calorimetry, several mixtures were tested for stability and compatibility. None of the mixtures at a 99% oxidizer, 1% additive level differed significantly from the pure oxidizers except for 2,2'-dipyridylamine in S-HAN5. This seems to indicate that the additives are compatible with the oxidizers but they do not make the oxidizers any more stable.

A COMPARISON BETWEEN RELATIONAL DATABASES AND OBJECT-ORIENTED DATABASES

Thomas J. Angell

Abstract

This paper discusses several attributes common among database and database management systems. It also compares two types of database management systems, Relational and Object-Oriented. A database can provide users with a better way of finding or updating data, but it must correspond to the real world and be user friendly in order to readily accomplish this task.

THERMAL STRESSES IN COMPOSITE MATERIALS

Christine M. Baker
Northmont High School

Abstract

The summer research program entailed not just one project, but a large variety of interesting activities. The primary concern was assisting Mr. Bryan Foos, of the FIVEC office in Wright Laboratory, with the research for his Ph.D. dissertation. His research involves the use of unintrusive extrinsic Fabry-Perot interferometric strain sensors embedded through the lamina thickness of a carbon epoxy composite material to monitor the transverse normal stress / strain. Mr. Foos is also running some complex FORTRAN computer programs on the Ohio State University Cray Supercomputer in order to validate the programs with actual experimentation. Some of the tasks completed this summer have included submitting the programs to the Cray Super computer and performing complex data manipulation from the extensive output produced from running these programs. Mr. Leonard Truett also requested help during the short duration this summer. Mr. Truett, of the FIVS office in Wright Laboratory, needed assistance with a massive amount of data using digital image processing. Other assignments have included writing an instruction manual for a photomicrographic camera and mastering the Nicolet data collection system to be used to acquire data during the testing in the TAVLAB (thermal and vibration lab).

REINVENTORY OF THE TECHNICAL INFORMATION

CENTER OF TYNDALL AFB AND

BANYAN INSTALLATION IN THE PENTAGON

Eugenia D. Baker

Summer Apprentice

Department of Defense

Tyndall Air Force Base, FL

Abstract

During the course of eight weeks this summer I was placed in two separate directorates; in the TIC, refferred to as the Technical Information Center, where I helped with inventory of the some 12,000 books there, and SC, refferred to as the agencys head computer directorate. I would say that both of these directories are a basis towards the agencys functioning as a whole, and I learned a great deal while working in both. Another major attribute towards working along with the computer experts in SC was that I learned the complete installation process of the Banyan system and actually had a chance to practice my newly accquirred knowledge by accompanying the directorate on a one week TDY trip to the Pentagon and installing the system in some 160 PC's in "Civil engineering Country." I believe that this was an exceptionally good and enlightening experience tfor me in that I became able to assume an overall better generalized assessment of the 'working field' and make a knowledgably better decision about what I would like my future to hold. I will also count it as an experience I will never forget.

C PROGRAMMING FOR DIGITAL ANALYSIS, AND THE UNIX OPERATING SYSTEM

Jonathan C. Bakert
Sauquoit High School

Abstract

In much more depth, the C programming language was studied and was implemented to compose various tools for the ATTI (Analog Test Tool Integration) package under Xwindows. Tools such as a sliding FFT algorithm with a movable 'window' were written along with the C source code for a signal to noise calculator. Also, code to read and write the header file of the Tektronix DAS 9200 (Digital Analysis System) was used to store critical information during analysis. Along with these functions, smaller, more versatile functions were written as part of a larger library to make repetitive tasks, such as the copying of matrices or the summation and squaring of an array, easier. The Unix operating system was also studied and used with more proficiency.

Analysis of a Three-Penetrator Concrete Penetration Using PATRAN

Jennifer R. Bautista
High School Apprentice
Warheads Branch, Computational Mechanics Section
WL/MNMW

Abstract

To investigate the effects of simultaneous impact of multiple penetrators into a concrete target, a scaled model of a Hardened Target Ordnance Package (HTOP) hard concrete penetration was modeled using the EPIC hydrocode. The intent of the calculation was to determine if a wave synergism would occur in the "tripak" problem, incurring more damage to the concrete target than a single penetrator might. The tripak problem was modeled using EPIC, and the output was processed, using PATRAN, into graphics noting pressure, stress, strain, damage, and temperature of the target at six intervals during the calculation.

A STUDY OF SILK COATINGS ON THIN FILMS

Jessica M. Behm
Fairmont High School

Abstract

The coatings of silkworm silk on thin films was studied. A 9.3M LiBr and several concentrations of silk solutions were made to determine the effect of lasers on thin films covered with these solutions. Experimental results indicated that these solutions will need to be altered to gain the expected results.

A STUDY IN THE DEVELOPMENT OF SPECIALIZED SOFTWARE FOR PRI AND HISTOGRAM GENERATION IN SUPPORT OF SIGINT RESEARCH AND DEVELOPMENT EFFORTS.

Craig M. Belusar
Oneida High School

Abstract

The goal of this project was to produce software that would generate random generated Pulse Repetition Intervals (PRI's) and display a graphic representation of the data. The solutions to this problem included learning about computer hardware and software, radar signal propagation, and computer graphics. The result of this project was a set of programs that generated random PRI's based on specified parameters with the ability to display the PRI's in a histogram and / or pie chart display. Solving these problems and writing the software increased my knowledge of computers and software development to a great extent. It also proved beneficial to the ELINT Development Facility (EDF) at Rome Laboratory as it aided in their research in signal intelligence.

THE BIOLOGICAL EFFECTS OF ADN ON HEPATOCYTES: AN EPR STUDY

Sara E. Berty
Carroll High School

Abstract

This project investigated the biological effects of ammonium dinitramide (ADN) on hepatocytes. It was hypothesized that ADN decomposes to form free radicals which would be deleterious to the body. The effects of ADN on the liver were studied because regardless of the route of exposure, once inside the body it will enter the bloodstream and ultimately pass through the liver. The leakage of the enzymes aspartate aminotransferase (AST), alanine aminotransferase (ALT), and lactate dehydrogenase (LDH) was measured to ascertain the viability of WB 344 hepatocytes after a 24 h exposure to ADN. Electron paramagnetic resonance (EPR) spectroscopy was used to determine if ADN induced the production of free radicals. As free radicals are highly reactive, α-phenyl-tert-butyl nitrone (PBN) and 5,5-dimethyl-1-pyrolline-1-oxide (DMPO) were used to trap the radicals produced in the experiments. Incubation of hepatocytes with 2.8 mM ADN for 24 h was toxic to 50% of the cells. Cells exposed to ADN produced free radicals in the presence of both PBN and DMPO. The generation of free radicals using PBN seemed to be pH dependent. Further studies are necessary to determine the effects of ADN on the possible target organs, the lungs and skin.

Arc-Second Raster Chart/Map Digitized Raster Graphics
Data Exploitation

Shawn H. Bisgrove
Rome Free Academy

Abstract

A program was developed using C in a UNIX environment on a SPARC 10 running SunOS 4.1.3 to efficiently exploit ARC Digitized Raster Graphics from a mounted compact disc and create multiple outputs. Utilizing SyBase's Structured Query Language as a standardized storage method this program populates the database tables. A raw output and a formatted output can also be created to assist in cataloging ADRG material. This program is useful when attempting to catalog large collections of ADRG cartographic material.

MODELING ENGINE TEST FACILITY CELLS IN VISSIM

Ryan B. Bond
Tullahoma High School

Abstract

A math package called VisSim was used to model a ram-inlet turbine engine test cell. The package was evaluated for ease of model construction, modification and use. Necessary model run time was also noted. The evaluation indicated that, for analysis purposes, VisSim is preferable to FORTRAN for many test cell models. VisSim did present problems with solving implicit equations and with expressing some logic statements.

Analysis of Spectrum Loading of SCS-6 / Timetal®21s

Timothy B. Booher

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Introduction:

Titanium matrix composites (TMCs) are being considered as materials for structural applications in advanced aerospace applications which involve exposure to both mechanical and thermal cycling at high temperatures. TMCs offer many advantages over superalloy components in high temperature structural applications. Nickel superalloys have worked well in the past, but they are heavy and in current applications are being used at temperatures within a few hundred degrees of their melting temperatures. TMCs offer the potential to replace these alloys with ones that offer higher temperature capability, lower density, and higher stiffness.

At present, however, certain problems exist in the application of TMCs. Besides the high cost of the materials, the titanium alloys suffer from a severe interstitial embrittlement during air exposure at elevated temperatures. Within the Timetal®21S material, high temperate air exposure promotes an alpha precipitation within the normally beta matrix (oxygen is a potent alpha stabilizer). This severely reduces the ductility of the material as well as its fatigue resistance. In composite form, the embrittlement can be so severe that the matrix ductility can drop below the theoretical minimum ductility required for load transfer between fiber and matrix. Also, the oxidizing environment will attack the fiber coatings, typically C or TiB_2, leading to a reduction in the strength of the fiber and a brittle reaction zone at the fiber / matrix interface.

CARDIAC MEASURES OF PILOT WORKLOAD: THE WRIGHT-PATTERSON AIR FORCE BASE AERO CLUB STUDY

Michael J. Bruggeman
Archbishop Alter High School

Abstract

As flying a modern aircraft becomes an exceptionally demanding task, both the mental and physical workload of the pilot and flight crew becomes more complex and demanding. Since the physical/mental workload is difficult to ascertain and measure, the psychophysiological data are preferred since they can be used to show pilot/crew workload. The Psychophysiological Assessment Test System (PATS) has been developed to obtain and then analyze these types of data. In this case, the PATS will be used to measure the pyschophysiological data, particularly the cardiac measures, obtained during the Wright-Patterson Air Force Base Aero Club Study. This study gives researchers the opportunity to compare physiological data collected from private pilots flying a small, non-military aircraft with similar data collected from pilots flying military missions in high performance military aircraft.

CHEMICAL DECOMPOSITION USING NON-THERMAL DISCHARGE

Kimberly N. Cabral
Choctawhatchee High School

Abstract

Chemical decomposition produced by a non-thermal discharge process was studied to establish the efficiency of a coaxial reaction tube. Gaseous toxicant TCE was combined in a flow with O_2 and H_2O vapor to form the working gas. The working gas flow passed through the reaction tube, and concentrations of the gas were monitored on input and exhaust ports. Electrical power and concentration reductions (%) were utilized to calculate the process efficiency. Parameters were varied to examine their affect on the efficiency. The varied parameters included flow rate, TCE concentration, power, and frequency of applied electrical voltage. Efficiency is defined as the ratio of a theoretical energy per molecule to the input energy divided by the number of TCE molecules destroyed. Experimental results in the 1-watt range indicate a higher efficiency and show a direct relation between efficiency and flow rate, and efficiency and concentration.

ACCURACY VERIFICATION EXERCISE FOR THE COMPOSITE HIGH ALTITUDE MANEUVERING PBV PROGRAM (CHAMP)

Robyn M. Carley
Fort Walton Beach High School

Abstract

CHAMP version 1.2.0, software used for imaging and modeling, had not been quantitatively tested after distribution. Using elementary test cases for which the theoretical intensity values could be calculated, the output of the CHAMP software was analyzed for accuracy. Five geometric shapes were used, and the intensities of the objects were measured with range decreasing over 100 km. Testing methods, errors discovered, and methods and results of correction are discussed.

THE ADAMS PROJECT

Jason P. Carranza
Chaminade-Julienne High School

Abstract

During the summer of 1994, I participated in the Air Force Office of Scientific Research (AFOSR) High School Apprenticeship Program as an apprentice of Charles B. Hicks and Clive L. Benjamin. During the first half of the summer I spent most my time with Mr. Benjamin, learning about the C language and the UNIX operating system. I programmed several mathematical programs in the C programming language on a UNIX-run ALPHA workstation and SUN SPARCStation 2. In addition, I spent time evaluating a new piece of software which was an electronic catalog for reuse. During the second half of the summer with the help of Mr. Hicks, I was able to increase my proficiency in ADA, software engineering, and software design. A problem was given to me by Mr. Hicks, and I was instructed to first design an algorithm to meet the requirements, secondly refine the algorithm to pseudocode, then program it into an ADA development environment, compile, and debug the program. Finally, I repeated the process when modifying the program to meet stricter requirements of Mr. Hicks. This program in return was used in the ADAMS project Mr. Hicks was working on at the time.

MACH-FLOW ANGULARITY PROBE CALIBRATION

Robert B. Cassady
Coffee County Central High School

Abstract

Pratt and Whitney is testing a Scramjet engine for the National AeroSpace Plane. They contracted Calspan Corporation to calibrate the Mach-flow angularity probes for the test. Calspan calibrated the MFA probes for use in a facility that uses air for the flow, which has a gamma (ratio of specific heats) of 1.4; however, Pratt and Whitney is using the MFA probes in an environment other than air that has a gamma of 1.33. My assignment was to find out if there is a significant difference in the data results if theMFA probes calibrated for a gamma of 1.4 are used in a gamma of 1.33 environment.

THE DIRECTIVE ROLE OF STATISTICS IN MEDICINE

Heather E. Castellano
High School Summer Research Apprentice

Abstract

Statistics in medical research has revealed to physicians and researchers what they are capable of accomplishing through the analyzation of quantitative data. Statistics provide methods for detecting the probability of error in research results. The diversity of statistical applications allows almost any type of scientific research to be analyzed. With the interpretations that statistics provide, the conclusions of a scientific findings in medicine are substantiated; thus reducing scientific error and increasing the speed of research advancement.

A PASCAL PROGRAM FOR A PC-BASED DATA ACQUISITION SYSTEM

Christopher J. Chadwell
Madison High School

Abstract

A PASCAL program for a PC-based data acquisition system was developed to examine the relationship between heat and efficiency in a Molecular Sieve Oxygen Generating System (MSOGS). The MSOGS setup generated multiple analog voltages that came from various temperature amplifiers, pressure transducers, and flow meters. A 12-bit Metrabyte multi-function I/O card was used with a PC to perform the necessary analog-to-digital (A/D) conversions during the data collection process. The PASCAL program monitored and controlled the Metrabyte card while managing data collection, streaming data to disk, and data storage. The resulting binary data stored on the disk was converted to ASCII format using a binary-to-ASCII converter program. The results of the program repeatedly showed no loss of data integrity during data collection of 30 minute, multi-channeled MSOGS runs.

DEVELOPMENT OF ASTROS, VERSION 11 FOR A PERSONAL COMPUTER

George P. Choung
Beavercreek High School

Abstract

This subject concerns the development of the computer program called ASTROS. This program currently is being used on several different types of computers, mostly the industry's best UNIX workstations. The source code of ASTROS is written in FORTRAN 77. Although FORTRAN 77 is a standard, there are some differences between the many different FORTRAN compilers. The task at hand was then to find these differences, and create options to bypass the difficulties.

EVALUATION OF HEAD SCANS FROM THE HGU-53/P HELMET SURVEY

Eleanore Chuang
Harvard University

Abstract

The recent development of three-dimensional anthropometric techniques by the Computerized Anthropometric Research and Design (CARD) Laboratory at Wright-Patterson Air Force Base uses state-of-the-art computer graphics and laser technology to greatly enhance the capability of Air Force design engineers to improve the fit and effectiveness of essential protective flight equipment. For the first time, this new design tool makes available to both government and private industry crucial data about the shape of the head, that facilitates design of helmets, oxygen masks, helmet-mounted display units, and many other types of headgear. It also lends itself to advanced biomedical applications, such as production of burn masks and prosthetics.

With the use of a Cyberware Echo Digitizer laser scanner, the CARD Laboratory has compiled a large database of head scans from several surveys of Air Force pilots throughout the United States. Once scans are collected, evaluation is necessary to determine whether the data is reliable and useful, and if not, whether it can be made reasonably reliable and useful. This paper focuses on the first evaluation of the quality of three-dimensional head scans, completed on the HGU-53/P helmet survey from the CARD database.

CONCENTRATIONS OF RADIONUCLIDES

Clayton Ciomperlik
High School student
Al/OEBA
Brooks AFB

ABSTRACT

It is finally being realized that our most valuable resource is being destroyed. Many issues have been brought forth on the extent of damage being done to the environment. I have decided to determine the amount of damage done by this long term abuse of our environment. Over a period of 2 weeks the lab personnel and I studied the concentrations of radionuclides in soil within a 5 mile radius of my house. I took 3 types of samples: water samples, soil samples, and a radon canister. These samples will enhance my knowledge of environmental science and give me an overview of the radionuclides which occur naturally in the earth. Based on concentrations there was no evidence that there was long term destruction of the earth.

ANALYSIS OF VARIOUS SAMPLES FOR THE PRESENCE OF METALS

Kara L. Ciomperlik
East Central High School

ABSTRACT

The main function of the Metals Section of the Armstrong Laboratory is to provide support for bases worldwide in the analysis of environmental and occupational samples for metal content. These samples include, but are not limited to, drinking water, wastewater, soils, sludges, biologicals, and air samples. The section analyzes an average of 10,000 samples per year with the average of four or five different analyses. The sample load is almost evenly split between occupational and environmental samples. Analysis of the sample is accomplished by using several varieties of spectroscopic instruments including Inductively Coupled Plasma (ICP). Flame Atomic Absorption (FAA), Graphite Furnace Atomic Absorption (GFAA), and Flow Injection Mercury System (FIMS). This section also manually prepares samples for mercury analysis.

Workstation Inventory Control Program

Thomas Clouse

Mentor: Ron Turner

Abstract:

A Database Program was created to inventory hardware and software for new workstation Computers. The program also records problems with the new systems.

NETWORK APPLICATIONS

Joseph A. Croswell
Mosley High School

Abstract

The decision of whether to put software applications on the network or on the individual computers' hard drives was studied. Different orientations were examined, and more questions were found than answers. The question of how many users needed the application became important. Other areas that were considered were performance, administration, and economics. It was determined that each application and each network should be considered separately according to speed, administration time, and money.

REFLECTED LASER COMMUNICATION SYSTEMS

Rhianna DaSalla
Space Experiments Directorate
Phillips Laboratory

Abstract

The study was done on a concept for a reflected laser communication system. The proposed communication system is achieved by directing a laser towards a retroreflector located at the remote point of the link. The remote site encodes telemetry on the reflected laser with an optical modulator. The primary advantage of this approach is that equipment at the remote sight can be extremely low in power and weight. Other benefits include less weight and volume required aboard the satellite, the complex parts are on the ground for easy access, and potential for very high data rates.

ADVANCED GAS TURBINE
ENGINE COMPRESSOR DESIGNS

Nick D. DeBrosse
Kettering Fairmont High School

Abstract

Advanced gas turbine engine compressor designs and design tools were studied. A MathCAD processor was used to calculate compressor thermodynamics. The results from the MathCAD processor were used to enhance a baseline fighter engine with a growth fan using program TERMAP. From TERMAP the enhanced engine was placed in a flight simulator in a F-16 to compare the old engine's flight envelope with the enhanced engine's flight envelope. With this theoretical engine and it's data, a preliminary design program to see an advanced compressor.

CHARACTERIZATION OF CORE SOIL SAMPLES AND PLANTS FROM TA A-22 TO DETERMINE CONTAMINATION

Nancy Deibler
Choctawhatcheee High School

ABSTRACT

Metal contamination in soil is a hazard to the environment. Testing of surface soil samples for heavy metal contamination has shown possible aluminum and iron contamination in some soil at Test Area (TA) A-22, which is a ground aircraft gun test area on Eglin Air force Base. Further investigation of metal contamination on TA A-22 was investigated. Core soil samples were taken 40 centimeters deep in the ground from TA A-22. The metal content of each soil sample was determined with a Portable X-ray Fluorescence Spectrometer. The pH of each soil sample was taken with the Expandable Ionanalyzer 940. The elements present, amount of each, and the pH of each soil sample was found and compared to controls of similar texture. The results show no detectable heavy metal contamination leaching into the ground. A second test was conducted to determine heavy metal uptake of plants on TA A-22. Persimmon leaves, Turkey Oak leaves, and Yucca plants were collected from TA A-22. The plant samples were processed for analysis with the Inductively Coupled Plasma Spectrophotometer (ICP) Analysis. Due to a malfunction of the ICP, analysis of the plants was not completed. Once the ICP analysis is conducted, heavy metal uptake of plants on TA A-22 will be determined.

STUDY, DESIGN, AND MODIFICATION OF THE DYNAMIC CONE PENETROMETER

Timothy O. Dickson
Rutherford High School

Abstract

The Dynamic Cone Penetrometer is used by the U.S. Air Force to test the shearing strength of soil of unpaved runways to determine the number of aircraft that can safely take off and land. The current design is bulky and requires the use of two operators. Captain David Weintraub, in his dissertation for doctor of philosophy at the University of Florida, designed an Automated Airfield Dynamic Cone Penetrometer (AADCP). The AADCP was assembled and studied for practical application. This study determined that this version of the AADCP would be impractical for use by the U.S. Air Force. A concept for a Modified Dynamic Cone Penetrometer was proposed. Like the AADCP, it requires only one operator, but instead of using an automated hammer, the Modified Dynamic Cone Penetrometer determines the distance penetrated to eliminate the recorder.

AEROSPACE ENGINEERING:

The Building of Computer Programs and Inexpensive, Simple Machines

Timothy G. Donohue
Carroll High School

Abstract

Two of the most important jobs of the aerospace engineer include the building of computer programs that analyze and simplify data obtained in testing, and the designing and building of simple machines used to test the capabilities of certain airplane parts. During my eight weeks acting as an apprentice aerospace engineer, I took part in both of those jobs. The first program I built numerically integrates the angular rate data from the AMIT (ADAM MACE Integration Test) ejection test at Holloman AFB, New Mexico, on April 15, 1994, to obtain orientation data throughout the ejection event. The second program was used with a data file (20 columns wide and over 100,000 rows long) from three F-111 ejection tests that measured pressure on the escape capsule throughout the ejection event. This program opens 19 new data files, each containing column #1 (time in seconds) and one of the other 19 columns of data. Finally, I designed a simple, inexpensive, efficient machine that holds an ejection seat and allows it to yaw and pitch to a certain angle. It can then be locked in place so that forces upon the seat can be measured.

Investigation of programming and UNIX applications in support of Computational Mechanics

Michael J. Dooley
High School Apprentice
WarHeads Branch, Computational Mechanics Section
WL/MNMW

Abstract

Computational Mechanics, designated MNMW was established to support in engineering analysis of defense experiments done at Eglin Air Force Base, Florida. I was given two assignments, first to explore several UNIX utilities and report on their benefits to Computational Mechanics under the direction of my mentor Mr. Michael E. Nixon. Next I was to manipulate a result file from an EPIC 94 calculation of an experiment performed at Range C-64 on Eglin, A.F.B. To accomplish this, I first used the UNIX script language awk, then Lahey, F77, and Microsoft FORTRAN. This would benefit my section in several regards. First, it would introduce me to the processes and applications of this section and prepare me for larger projects next year. Next, I would gain useful knowledge in UNIX utilities that I could then brief my section on, and they could decide which would be useful to their work. Next, the manipulation of the time history data file mentioned earlier would allow my section to gain a clearer understanding of the data collected.

CONSTRUCTION AND TESTING OF A DUAL PHOTODIODE RECEIVER UNIT

Alexander E. Duff
La Cueva High School

Abstract

The speed of a laser being swept by a scanning mirror was important to measure. The speed of the beam could be measured if it was known how long it took to travel across a known distance. An electronics box was constructed for this purpose. The box included photodiodes that responded to light when it passed over them. The speed of the laser could then be measured using an oscilloscope that measured the time interval between the beam hitting the photodiodes. After the box had been constructed, testing was done, and the box performed its purpose flawlessly.

A STUDY OF LINER COMPOSITIONS
FOR SOLUTION PROPELLANTS

Bridget C. Engelhardt
Apprentice
Paraclete High School

Abstract

The strength of adhesion of epoxy resin liners to solution propellants was studied. Test specimens (R-BITS) were prepared by coating aluminum plates with various liner materials then placing a solution propellant (composed of hydroxyl ammonium nitrate and polyvinylalcohol) between the liners. The strength of the adhesion of the liner to the solution propellant was tested using rectangular bond-in-tension samples on an INSTRON test machine. The results indicated that neither conventional liner nor epoxy formulations (utilizing Trimer acid and ERL 4221) adhered to the solution propellant sufficiently to be useful as rocket motor liners.

THE CONVERSION OF MILLIVOLTS MEASURED FROM THERMOCOUPLES INTO CORRESPONDING DEGREES FAHRENHEIT USING THE TABLE LOOKUP METHOD

Michael L. Fann
Tullahoma High School

Abstract

It was determined that a new program was needed to convert the millivolts measured from thermocouples into corresponding degrees Fahrenheit. This program should incorporate a new method entitled table lookup using a millivolt index into a table of temperature values and linear interpolation between values. The table lookup technique would replace the use of polynomial curve fit equations of the thermocouple tables. The new method would read the thermocouple tables and select the temperature value that corresponds with the measured millivolt value. This method of converting millivolts to temperature should prove to be more accurate. It was desired that this method would meet within the new desired tolerance of +/- 0.05 degree over the temperature range of -30 to +300 degrees Fahrenheit and a tolerance of +/- 0.1 over the rest of the range. A program was developed to incorporate the table lookup method of converting millivolts to corresponding degrees Fahrenheit. This program also enables the user to convert degrees Fahrenheit to millivolts. After completion, the program met the desired tolerance and with this improved accuracy the program could replace the current conversion program.

AN OPTIMIZATION STUDY ON A 99% PURITY MOLECULAR SIEVE OXYGEN CONCENTRATOR: EFFECTS OF PURGE ORIFICE SIZE

Maureen D. Finke
New Braunfels High School

Abstract

The purpose of this work was to determine the effects of purge orifice size on the performance of a 99% purity molecular sieve oxygen concentrating system. These systems separate oxygen from compressed air through the process of pressure-swing adsorption. Several purge orifice sizes were evaluated. The study showed that an orifice size of 0.040 inches I.D. gave the highest oxygen recovery rate while the concentrator produced 99% purity oxygen. Further, the optimum inlet air pressure and cycle time for the concentrator was 35 psia and 14 seconds, respectively.

AN IMPLEMENTATION OF THE MULTIPLE SIGNAL CLASSIFICATION ALGORITHM (MUSIC) IN MATLAB

Stacy Fitzsimmons
Vernon-Verona-Sherrill Central High School

Abstract

An algorithm to separate multiple signals on an antenna using spatial processing was implemented in MATLAB using concepts from linear algebra. A simulation was created with a given number of antenna array elements and a given number of incoming signal wavefronts, accompanied by noise. Functions were written to generate the signal environment, the noise waveforms, the array manifold, and the array data in order to set up the simulation. The MUSIC (Multiple Signal Classification) algorithm was used to calculate the angles of arrivals of the incoming signals so they could be separated from the other incoming signals and processed.

Physical and Chemical Characterization of Columbus Air Force Base Aquifer

Angela Foth
High School Apprenticeship Program

Mosley High School
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Abstract

The field experiment, called the Natural Attenuation Study (NATS), will be conducted on an aquifer at Columbus Air Force Base, Mississippi. A large hydrocarbon NAPL (Non Aqueous Phase Liquid) will be emplaced in the aquifer, and soil characterization before and after the emplacement of the NAPL will be measured. One of these measurements will be the determination of iron levels. This study will concentrate on the iron analysis performed on several soil samples from the Columbus aquifer prior to the emplacement of the NAPL. The iron content will be determined using colorimetric determination. The Natural Attenuation Study will be used to test the hypothesis that ferric iron oxide minerals commonly occurring in oxygenated aquifers degrade hydrocarbon contaminants after oxygen has been locally depleted by aerobic degradation. This information is needed to determine whether the aquifer has an oxidizing capacity considerably in excess of that provided by the dissolved oxygen in ground water. The data obtained during this study will be used to test predictive models during the course of natural attenuation. These models will help determine the fate of groundwater contaminants, make contaminant cleanups more efficient, and help in developing methods for slowing down the spread of these contaminants.

A STUDY OF THE MORTALITY RATE OF THE TEST ORGANISM DAPHNIA PULEX WHEN EXPOSED TO A BROOKS AIR FORCE BASE WATER SAMPLE USING THE REFERENCE TOXICANT SODIUM CHLORIDE

Andrea L. Freeman
Judson High School

Abstract

A forty-eight hour study of the acute toxicity of a water sample generated on Brooks Air Force Base was conducted. Laboratory-bred Ceriodaphnia pulex were placed into the test water, and the survival of the test species was monitored in order to determine both the possible toxicity of the dilution water and also to determine any possible inherent defects within the test organisms which are bred and contained within the laboratory. The reference toxicant sodium chloride was utilized. The EC_{50} (concentration in which 50% of the organisms died) was mathematically determined and compared to the given range specified by the Environmental Protection Agency. Reference toxicity tests are used to determine the soundness of the effluent toxicity data generated by the toxicity tests routinely performed here at Brooks Air Force Base[1].

A STUDY ON THE EFFECTS OF CHRONIC INTERMITTENT EXPOSURES TO MEDIUM +GZ

Jeff Gavornik

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Final Report for:
High School Apprentice Program
Armstrong Laboratory

Abstract

With the wide spread use of high performance aircraft capable of sustained high +Gz the USAF has interest in the effects of acceleration and +Gz on the human body and mind. As a continuation of a previous study on chronic multiple high +Gz, male Sprague-Dawley rats were exposed to +15 Gz on a chronic intermittent schedule using a small animal centrifuge. Instrumented control groups were exposed to +.5Gz (base) and a non-instrumented positive control group was kept in the vivarium. Histological data is still being processed, but initial anaylsis points to a relatively small amount of stress being placed on the subjects due to acceleration and little neurological damage is expected to be found.

LIGHTING CALCULATION STUDY AND SOFTWARE EVALUATION

Derek E. Geeting
Shelbyville Central High School

Abstract

Lighting systems and calculation techniques were studied. Several calculations were made by hand and compared to known solutions. Next, new software programs were used to recalculate the lighting systems. The results produced by the software were compared to the previous known solutions and hand calculations. One of the programs proved to be more accurate, quicker, and easier to use than the previously used hand calculations.

THE CONSTRUCTION OF A MODEL SOLAR POWERED CAR

Daniel C. Ghiglia
Sandia Preparatory School

Abstract

A model solar powered remote control car was constructed to run only on the power of the sun. The power of the car was supplied by a solar array consisting of four strings constructed of eleven cells in parallel. The object was for the car to not only run on the power of the sun, but also to allow the operator to control the speed and the steering of the vehicle. Because several of the parts were purchased at a local hobby shop, the car had to be constructed to fit them.

ENVIRONMENTAL RESTORATION TECHNOLOGIES RESEARCH AND DEVELOPMENT

Mark W. Giles

ABSTRACT

This work was sponsored by the Armstrong Laboratory Environics Directorate at Tyndall Air Force Base, Florida. Program management and environmental cleanup technologies for removing fuels and solvents from soils and groundwater at contaminated Air Force Bases are the focus of this agency's research and development activities. The program documentation essential for the initiation and direction of the development efforts are explained, such as the program planning preparation from contractor proposals. The main environmental technology observed during the period of June to August 1994, was the Radio Frequency/Vapor Extraction technology.

A STUDY OF POLYMER DISPERSED LIQUID CRYSTALS

Ajay Goel

Centerville High School

Abstract

Polymer dispersed liquid crystal films were studied. Films were made by mixing a monomer, a liquid crystal, a coinitiator, and a photosensitive dye. In some situations, a cross-linker was added. And in other cases, a surfactant was added. After the "syrup" was dissolved using an ultrasonic tip, a thin film of the mixture was exposed to different intensities of different kinds of light. After regular phase separation of the liquid crystal was observed, Bragg gratings were also produced in the film by exposing it with two laser beams simultaneously.

THEORETICAL STUDY OF RADIATION AND HEATING EFFECTS IN ACOUSTO-OPTICAL DEVICES

Tad L. Goetz
Sandia Preparatory School

Abstract

The thermal and acoustic properties of various acousto-optic semiconductors and oxides were researched. The Photonics Research Group at Phillips Laboratory at Kirtland Air Force Base provided experimental data on spatial intensity deflection for crystals that were exposed to radiation. A theoretical study was conducted to ascertain the ability to predict the acousto-optic spatial intensity deflections due to the nature of the materials and their thermal properties. Practical applications for such devices and a brief explanation why this research is valuable are outlined.

Automated Integration of LADAR Imagery and TIFF Structure for Flexible Sensor Analysis

Christie W. Gooden
High School Apprentice
Seeker Technology Evaluation Branch
WL/MNGI

Abstract

Last year, an existing program was modified to decrease man-in-the-loop hours and increase the output of pertinent data. Future plans included automation of the complete obtaining and displaying process of LADAR data written in the C programming language as opposed to the Pascal language utilized beforehand. Due to extenuating circumstances, a better way of displaying data was used to complement last years project; Tag Image File Format, better known as TIFF.

THE USE OF LABVIEW FOR SERIAL DATA TRANSMISSION

Jennifer A. Groff
Franklin County High School

Abstract

The application of Labview to serial communications was studied. The subject of the experiment was a Sony Hi8 mm videocassette recorder , on loan from the Plume Data Center video lab at Arnold Engineering and Development Center. A personal computer was connected to the VCR by a standard RS-232 line to allow serial data transmission. A Panasonic video camera and a Sony monitor were also attached to the VCR, the camera for input and the monitor for display. A program using Labview was written to remotely control the VCR. This system allowed the computer to control the basic functions of the videocassette recorder.

**HEAT PIPE COMPATIBILITY
WITH AIRCRAFT**

Gary Lee Grogg
Carroll High School

Abstract

Heat pipes are being tested for coolant systems on aircraft. Experiments are being conducted to evaluate the heat transport capabilities and stability of a single pore capillary pumped heat pipe loop. Variables considered for the heat pipe loop included heat load, vibration frequency, and the capillary tube ID (inner diameter). Data was obtained using thermocouples spaced along the pipe, and a pressure transducer. Results showed that increased activity and instability followed an increase in heat content. Additional instability was a result of vibrational forces; however, meniscus stability appears to be enhanced when the effects were used in conjunction.

Additional testing is also being conducted on a Russian developed capillary pumped loop heat pipe. The flexible design allows the evaporator and condenser sections to be oriented at various angles and height differences. At steady-state, evaporator and condenser temperatures, as well as the temperature difference determines the efficiency and limitations of the pipe. From the acquired data, conclusions can be drawn about the compatibility on aircraft.

The Analog Systems In Test Cell 22

Matthew T. Gudorf
Wright Laboratories Test Cell 22

Abstract

The data acquisition systems of Test Cell 22 are comprised of two Sun Workstations. One works as analog in and the other is analog out. The Suns drive two Creates again one as analog in the other as analog out. Each Create contains cards. These cards use pressure and voltage to control the experiments and gather the data from the experiments run in Cell 22. One card will control one input or output such as a valve or thermocouple. At the present time the system is set up to accommodate a compact heat exchanger with a single catalyzed or uncatalyzed tube. All of the data to be gathered will enter through the input Create. All of the controls of the experiment are handled through the output Create. The data from the Test Cell, Creates, and Suns is all transferred on fiber optic cable. The speed at which all of the information from each input source is gathered is very critical in reducing the time that a correction can be made to keep the controls in there proper ranges. Due to this the speed is pushed to its maximum collection rate at about one cycle per second. This generates very large amounts of numbers in a very short amount of time with the problem being that if the input computer generating possibly faulty numbers the output computer will attempt to correct the numbers to there given ranges, and from that point generation of faulty data begins to occur. The proposed plan is to write a program to read predetermined output with the input computer and generate the same numbers every time the program is run. (see fig 1)

CAD: A TESTING OF THE EFFECTIVENESS OF PROCESS DESIGN

Brian J. Guilfoos
Kettering Fairmont High School

Abstract

The purpose of this paper is to briefly review the activities of my summer, most specifically in the areas of process design and it's applications. My primary projects over the summer were the entry of data into a Macintosh for a program the lab was developing, and the machining of some parts by using a process design enhanced CAD program.

PROGRAMMING FILTERING ROUTINES IN THE C PROGRAMMING LANGUAGE

Michael L. Gunzburger
Kettering Fairmont High School

Abstract

A large part of my experience at WPAFB this summer was learning the C programming language. A few initial basic tasks were assigned to help me become more familiar with the language. After becoming fairly comfortable with C, I wrote a program that took a signal (a sum of sines wave) and "disrupted" that signal with "noise" (a jagged, random wave). I then wrote three separate filtering routines that filtered out the noise in an attempt to convert the disrupted signal back into the original, clean signal.

The Information Superhighway: Still Under Construction

David W. Gurecki
Rome Catholic High School

Abstract

Advances in multimedia technology will greatly affect the future of computers. The "Information Superhighway" is a term referring to the exchange of almost any ty[illegible] information over a vast, world-wide super-network of computers. This network exists today (commonly ref[illegible] Internet), and the technology to interface video, audio, imagery, and data into computers also exists today. However, mucn of this technology is still in the development stage, and there are problems that have to be resolved.

This report discribes some of these new areas of multimedia and communicating technology experimented with, the problems which can arise, and some possible solutions to these problems. It covers two applications that were developed during this period ("WEB-Link" and "ScanRes").

A STUDY OF THE NITROBENZENE REDUCTASE AND ITS REACTION WITH VARYING SUBSTRATES

Brian C. Harmon

A. Crawford Mosley High School

Abstract

Pseudomonas pseudoalcaligenes JS45 is a strain of bacteria that can grow on nitrobenzene as the sole source of carbon, nitrogen, and energy. This bacteria produces several enzymes that catalyze the biodegredation of nitrobenzene. The first enzyme studied was the nitrobenzene reductase enzyme which catalyzes the reduction of nitrobenzene to nitrosobenzene and to hydroxylaminobenzene. Our goal was to analyze the substrate range of this particular enzyme. Substrate groups that were studied are dinitrotoluenes, nitrophenols, and trinitrotoluene. 4-nitrophenol was the only substrate studied that was not reduced by this enzyme. This enzyme is somewhat unusual because it catalyzes the reduction of many nitroaromatic compounds. The second enzyme that was studied was the mutase enzyme. We used this enzyme in a semi-purified form. This catalyzes the transformation of hydroxylaminobenzene to 2-aminophenol. Our goal in this study was to find a method that was both accurate and repeatable in order to detect this transformation. Chemical and spectrophotometric ways were tested in trying to find a way to measure the mutase activity. One method was by adding 2,6-Dichloroquinone-4-cloromide (Gibbs reagent) to the reaction. A spectrophotometric method (A_{282}) was tried and is a method that will be used as a rapid means of detecting the enzyme in cell extracts.

DEVELOPING A SOFTWARE ENVIRONMENT FOR A HIGH PERFORMANCE SIGNAL PROCESSOR

Eric J. Hayduk and Richard A. Schneible Jr.

Abstract

A software environment for the FPASP5 (Floating Point Application Specific Processor v 5.0), a high performance signal processor, was developed. As an integral part of this development, the existing software was evaluated. Much of the Microcode and Assembly language had already been written. Still, debugging was required for all levels of the software environment. Further, function libraries had to be written for use by high level language programmers. Debugging consisted of writing test programs in FPASP5 assembly language, assembling them and simulating the programs on a VHSIC Hardware Description Language (VHDL) model of the FPASP5 processor. Results demonstrated that many tested instructions behaved properly and that several others contained bugs which needed to be documented and corrected. When an instruction worked correctly, in many cases, a function library had to be written. Tested instructions and constructed functions are discussed along with the necessary skills to implement this project, problems, corrections, and future steps to complete the development.

PROJECTS IN PATTERN THEORY

Douglas J. Heil
Vandalia-Butler High School

Abstract

Back propagation neural networks, software engineering, and the parity function were studied. A back propagation neural network was taught and tested. C++ code was transfer from a UNIX station to a PC. The parity function was studied.

HIGH SURFACE AREA CONDUCTIVE POLYMER FILMS USING ABEX EP-110 DOPED POLYPYRROLE

Laura Hemmer
High School Apprentice
Fuzes Branch
Wright Laboratory Armament Directorate

Abstract

In recent years, researchers have found numerous applications for conductive polymers. For example, polymer films can serve as electrodes in capacitors [1]. The goal of this project was to increase the surface area of conductive polymer electrodes thereby increasing their capacitance. The method tested was to increase the surface area by electrochemically depositing a textured film of ABEX EP-110 doped polypyrrole. These textured polymer electrodes were then used to make a double layer capacitor [2]. The capacitance of the textured electrode capacitor was compared to a capacitor made from smooth polypyrrole electrodes to determine the effectiveness of this deposition method.

PRELIMINARY STUDY FOR APPLICATION OF IRMA SYNTHETIC SIGNATURE TO MODEL HAZARDOUS WASTE SITES

David B. Hernandez
High School Apprentice
Seeker Technology Evaluation Branch
WL/MNGI

Abstract

This project involved technology transfer from military use to civilian use specifically to detect and cleanup hazardous waste sites. The sensors that the military uses to detect enemy outposts can be used to detect hazardous chemicals and can give valuable information as to the cause of the environmentally unsafe chemicals and how best to dispose of them in a safe, clean fashion. This process would save numerous man hours in trying to detect a waste site and in trying to clean it up. Even small traces of a hazardous chemicals would show up using Irma. This helps to minimize the area of treatment and maximize the time available for cleanup. Currently, WL/MNGI is working on the application of Irma to automatic target recognition. The goal of this project is to see if it is possible to apply those same techniques to locate hazardous waste sites and what those sites are composed of.

PARALLEL GASEOUS FUEL INJECTION INTO A MACH 2 FREESTREAM

Melanie L. Hodges
Research Apprentice
Advanced Propulsion Division
Wright Laboratory
Wright-Patterson Air Force Base

Abstract

Planar Rayleigh/Mie scattering and Acetone Planar Laser Induced Fluorescence (PLIF) flow visualization are presented for helium injected at sonic velocities from an extended strut into a Mach 2 freestream. The turbulent structure and penetration characteristics of the helium injected parallel into the flow at three different nozzle-to-freestream air pressure ratios were examined. Typical features of the flow, including a barrel shock, Mach disk, recompression shock, and recirculation zones were evident in Rayleigh/Mie and Acetone PLIF images taken from three different views along the flow. Mie scattering images reveal the presence of a conical shock in the near flowfield, upstream of the recompression shock in the highly overpressurized cases. Jet spread was insignificant for all case studies. This investigation will be used as a baseline study for comparison in future mixing enhancement studies utilizing different injector geometries.

THE KNOWLEDGE SURVEY AND ASSESSMENT (KSA) PROJECT

Wesley R. Hunt
James Madison High School

Abstract

The objective of this apprenticeship was to assist in the development of the Knowledge Survey and Assessment (KSA) project, also referred to as the "20-Questioner". The goal of the KSA Project is to measure the depth and breadth of technical knowledge possessed by airmen in a wide variety of technical areas. The first step of the KSA project is to transfer questions from paper-and-pencil booklets onto a computer and to develop an automated system of administering the tests and assessing their results. Then, over the next several years, data will be collected from knowledge surveys that will be given to thousands of airmen in conjunction with the project. Eventually, a large enough database will have been assembled to be able to employ an intelligent interrogation strategy to assess an airman's knowledge by a series of carefully selected questions. Development of the first stage of the project, item generation, was begun during the term of this apprenticeship.

FLUORODENITRATION OF AROMATIC SUBSTRATES

Venessa L. Hurst

Abstract

During this summer while in the HSAP program, I tried to demilitarize four different explosives. They were dinitrobenzene, nitrobenzonitrile, trinitrobenzene, and trinitrotoluene. They were each reacted with tetramethylammonium fluoride in the solvent dimethyl sulfoxide. I tested them after the experiment had taken place and looked to see if I could find the product that I was looking for. I found that product and this was proof that I did demilitarize the explosives.

PROGRAMMING DATA CLASSIFICATION PROCEDURES, TIME MANIPULATION FUNCTIONS, AND IMAGE PROCESSING PROGRAMS FOR THE AIRBORNE LASER EXTENDED ATMOSPHERIC COMPENSATION EXPERIMENT

DeLesley S. Hutchins
Albuquerque High School

Abstract

Due to their long range and extremely high speeds, lasers would make an ideal defense against missile attack. One design for a laser defense system is to use adaptive optics technology to negate the effects of atmospheric turbulence so that a laser mounted on an airplane can destroy enemy missiles. The ABLE ACE experiment at Phillips Laboratory will measure the propagation of a laser through the atmosphere, to further the design of such a system. Three programs were written as a part of this experiment.

The first program encodes and decodes identification bytes, which can be used to classify the different types of data recorded during the experiment.

The second program provides a variety of functions for manipulating the way time is recorded during the experiment.

The third set of programs will be used to decode the digitized raw video data into a form that can be analyzed by scientists at the laboratory, after the experiment is completed.

EXPERIMENTS IN FUEL RESEARCH

Ryan A. Jasper

Abstract

The importance of fuel in the military is only second to the safety level afforded to the pilots of military aircraft by making sure the fuel used is at the best possible performance levels. Numerous tests were run in the effort to analyze the performance of fuels in conditions similar to those found in aircrafts and to test the effectiveness of fuel additives and fuel additive packages.

SEGMENTATION OF AN M-60 TANK FROM A HIGH-CLUTTER BACKGROUND

Mark E. Jeffcoat
High School Apprentice
Advanced Guidance Branch

Abstract

This paper discusses three methods used in the attempted automation of the segmentation of M-60 tanks from a highly cluttered background. The first and least successful procedure used standard image processing tools. The second method, by neural networks, was not conclusively demonstrated to perform any better. The third method, segmenting pixels by comparing them to an ideal, proved to be most effective, but requires further processing to complete the segmentation.

HYPERBARIC MEDICINE

Karen M. Johnson
James Madison High School

Abstract

Hyperbaric Oxygenation is a medical treatment where the patient breathes 100% oxygen while in a chamber filled with compressed air. This treatment can be used for many different medical problems, along with surgery, antibiotics, or other therapy.

PERCEPTION OF THE SPOKEN STIMULI IN THE S.C.O.N.E. SYSTEM

Damian A. Kemper
Churchill High School

Abstract

It has long since been known that speech perception is made more difficult during the presence of competing background noise. Many Air Force personnel, such as pilots and crew members, work under such conditions; often times resulting in hearing loss. A system was developed at the Armstrong Laboratory Bioacoustics and Biocommunications Division, Wright Patterson AFB in Ohio, called the Speech Communication in Occupational Noise Environment. The system produces actual aircraft noise at the decibel level present in the cockpit and is designed to evaluate a pilot's performance in the cockpit during the presence of competing background noise. The system uses a version of the Modified Rhyme Test in the presence of this competing noise. This investigation is intended to be a pilot study to provide data on how well a normal hearing individual should score on the test and to determine whether or not there is a significant difference between scores with words presented by a female voice versus a male voice. Results from the test show that there is no significant difference between the two stimuli.

CARBON-CARBON STRUCTURES TEST

Andrew J. Konicki
Kettering-Fairmont High School

Abstract

The application of heat and pressure to Carbon-Carbon (C-C) is being studied. The primary objective of this test is to demonstrate the application of advanced C-C materials to full-scale, high temperature, hypersonic vehicle primary structures, such as aircraft.

THE EFFECTIVENESS AND ACCURACY OF CADRA SOFTWARE

BARRY KRESS
HIGH SCHOOL APPRENTICESHIP PROGRAM
AEROBALLISTICS SECTION
WRIGHT LABORATORY ARMAMENT DIRECTORATE

ABSTRACT

The purpose of these tests is determine the accuracy and effectiveness of software that locates the spatial position and angular orientation of a free-flight projectile. This software system is referred to as Cadra. The Cadra software is designed to decrease the time it takes to reduce the trajectory data received from testing projectiles at the Aeroballistic Research Facility(ARF). Results indicate that the Cadra software tested, which is still in its' developmental stage, needs to have some corrections made to it. However, these tests suggest that the logic behind the system is sound, and once a few errors are corrected the system should be operational.

A PARADIGM FOR STUDYING MUTUALLY ADVANTAGEOUS TRADE-OFFS IN MULTI-DISCIPLINARY DESIGN TEAMS: A COMPARISON OF EXPERTISE

Nathan R. Large
Northwestern High School

Abstract

In the Collaborative Design Technologies Lab, my research was centered around a laboratory experiment named the TRACE (Tradeoffs, Research, and Analysis in Collaborative Ergonomics) study. This study used an experimental paradigm, the design of a automobile navigation system, to observe the strategies of two experts who engaged in the task. These two experts received very disparate perspectives, in order to simulate a multi-disciplinary decision-making process, where contrasting viewpoints and objectives make negotiation necessary. My work involved transcriptions of the resulting conversations and codification of the data points reached. Results were analyzed to evaluate the paradigm itself and to compare the levels of real-world expertise.

THE PROCESS OF DISTINGUISHING BETWEEN EGGS OF *AEDES ALBOPICTUS* AND *AEDES AEGYPTI*

Trang D. Le
Brackenridge High School

Abstract

Lackland Air Force Base, TX conducted a surveillance program to monitor the populations of *Aedes* mosquitoes. At Brooks Air Force Base, TX tentative identifications were made by examining egg morphology. Specimens were reared to the adult stage for definite identifications. It was determined that Lackland AFB had an infestation of *Aedes albopictus* mosquitoes.

The Spacecraft Charging and Discharging Problem

Caroline H. Lee
Lexington High School
21 Waltham Street
Lexington, Massachusetts 02173

Abstract

In this report , I briefly describe the spacecraft charging and discharging problem which has been actively investigated by scientists at Phillips Laboratory and other places. The problem can be understood phenomenologically such as collisions, backscattering and emissions that lead to adhesion of electrons to the spacecraft or release of electrons from the charged spacecraft. A widely used probe, known as a Langmuir probe, for the studies of the addressed problem is discussed. Several new techniques to reduce or prevent spacecraft charging are elucidated.

OUT OF BAND FILTER CALIBRATION
TECHNOLOGY PROJECT

James Lemmons

Abstract

A new calibration procedure was needed for filters from the Plume Data Center . These filters have to be calibrated precisely through several orders of magnitude. Light from two sources was used to get all the wavelengths of light fom 800nm down to 200 nm. The light was passed through a diffraction grating spectrometer and into the detectors. Three different detectors were tested for their linearity to find the one with the best range. Many experiments were run checking the linearity of the detectors. The solution was to use different detectors over different parts of the wavelength range and combine them to make one calibration.

AN ANALYSIS OF OIL/GREASE IN WATER AND SOIL

Adriana Y. Lopez

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Abstract

An analysis of oil and grease in water and soil samples was conducted. Water samples were measured in 500 ml flask containers with and addition of freon and Sulfuric Acid (H_2SO_4). The samples were agitated by hand and by machine for three minutes. After this process, the samples were extracted into 10 ml cylinders. Soil samples were weighed out and freon was added. These were stirred for two minutes and extracted into cylinders.

Soil and water samples were investigated for pollutants. An analysis of oil and grease was conducted. Water samples were measured in 500 ml flask containers with freon and Sulfuric acid (H_2SO_4) added. These samples were agitated by hand and by machine for three minutes. After this process, the samples were extracted into 10 ml cylinders. Soil samples were weighed out and freon was added. These samples were stirred for two minutes and extracted into cylinders.

THE PSPH COMPUTER CODE AND THE WSCD REFERENCE DATABASE

Jeremy G. Pepper
St. Pius High School

Abstract

During my eight weeks working at PL/WSCD, I worked on two main projects. The first was creating a database of all of the reference materials that have been collected by the Space Kinetic Impact and Debris staff over their years of research. The second was familiarizing myself with the Parallel Smooth Particle Hydrocode which was developed at Phillips Laboratory in the Space Kinetic Impact and Debris Branch. The PSPH code is used to model hypervelocity impacts. The advantage that PSPH has over the SPH code designed by J. J. Monaghan{1} is that the PSPH code can be run over a multiple number of computers. This addition makes the program run much faster.

A STUDY OF THE CIV PHENOMENON AND THE SECONDARY AND BACKSCATTER ELECTRON EMISSION MEASUREMENTS

Matthew J. Pepper
St. Pius X High School

Abstract

CIV

My summer apprentiship supported two experiments. The first is the critical ionization velocity (CIV) phenomenon that was first proposed by H. Alfven in 1954 in his book *On the Origin of the Solar System.* In this process released neutral gas is ionized and then emits ultraviolet and visible light. I calculated how much light at wavelengths of 2.7 and 4.6 microns would reach earth from an orbit at 850 kilometers.

Secondary Electrons

There have been problems with spacecraft that buildup an electrical charge caused by high energy electrons. This charge interferes with the sensitive electronics on board a spacecraft. The builders of the spacecraft can try to counteract this charge, but there are no accurate measurements of charge production by high energy electrons on spacecraft materials.. The resulting high energy electrons can be measured by irradiating spacecraft materials in a vacuum chamber at certain angles and measuring the number of electrons emitted. This was the second experiment.

VALIDATION OF SYNTHETIC IMAGERY

Kyle D. Perry
Crestview High School

Abstract

The purpose of this research project was to produce graphs of real imagery comparing total attenuation(x axis) to the ratio of good pixels to total pixels(y axis). The graphs of the real images would then be compared to the graphs of the synthetic images to assess the similarity between the two. By proving the similarity by calculation, this would encourage use of synthetic imagery by research scientist involved in LADAR. In order to calculate total attenuation separate attentions had to be measured and entered into a formula on a spreadsheet. Average range, cosine factor, and good pixels to total pixels were taken using the Scoretool program. Weather attenuation at the 10.59102 micron wavelength was determined by using the Hitran PC program to graph total attenuation at that range and then transferring the graph to a text file. Reflectance was obtained from by using a table of values produced from prior research. Rain attenuation was found by looking up weather conditions for the test flights and entering the rain intensity during the flight into a formula. All these factors were entered into a spreadsheet and then into the total attenuation formula The relationship of total attenuation to pixel percentages was charted and labeled for future use.

INTEGRATED GENERATOR TECHNOLOGY

Daniel R. Pfunder
Centerville High School

Abstract

Several tasks were attempted and completed during the weeks between June 13, 1994, and August 5, 1994. These tasks all centered around the research of high speed gas turbine generators for aircraft power supply. These tasks covered a wide range of disciplines. These disciplines include: graphical analysis, computer aided design, text research, spreadsheet applications, computer programming, and lab work. This report will follow the v[illegible] the Wright Laboratory Ele[illegible]anical Technology [illegible] Engineers on the Integrated Power Unit (IPU) generator concept, and whenever possible, explain my contributions to the project.

Chemical Characteristics of the Rocky Creek System

Mary F. Pletcher
High School Apprentice
Environmental Assessment Branch
WL/MNSE

Abstract

Etheostoma okaloosae, commonly known as the Okaloosa darter, is considered to be an endangered species. In order to prevent the extinction of this fish, toxicity tests are being performed by contractors on the very similar *Etheostoma edwini* (brown darter). To conduct these experiments, the conditions of the habitat of both fish must be known. Thus the purpose of this project was to determine the chemical characteristics of the Rocky Creek system.

To determine the chemical characteristics, water samples were taken from five different locations on two different dates to compare normal conditions versus those present after heavy rainfall. Tests were conducted to determine volumetric flow rate, temperature, dissolved oxygen content, pH, conductivity, alkalinity, nitrate nitrogen composition, and turbidity.

The tests showed that an increase in volumetric flow rate after heavy rainfall was dependent on location, temperature changes were only slight with the mean temperature change being 0.68 degrees Celsius, and dissolved oxygen content is higher under normal conditions. The tests also indicated that the Rocky Creek system was acidic with the pH at all locations tested falling between the range of 4.1 to 5.3 under normal conditions and after heavy rainfall. Conductivity tests indicated that the total ionic concentration was lower under normal conditions than after heavy rainfall. Alkalinity generally increased after heavy rainfall as did nitrogen nitrate composition. Finally, turbidity tests showed that the quantity of particulate present was dependent on the location.

STUDY OF GLOBAL HYPERMEDIA NETWORKS

Anne E. Pletl
Rome Laboratory
Communications Networks Branch
Griffiss Air Force Base

Abstract

Global hypermedia networks which access hypermedia servers (i.e. text, audio, and video) were studied and demonstrated during my apprenticeship this summer at Rome Labs. In my research I have found that through the use of these revolutionary new projects, which are continually being upgraded, it is possible to contact another database (server) anywhere else in the world (given the proper address and hookup). Specifically, I developed a hypermedia server describing work performed at the Rome Lab Network Design Facility (NDF). I also updated several files, which enable the NDF easier access to the available information on the network. The following report will discuss my involvement with these hypermedia networks, the hypermedia server running on a SUN workstation, and explain their capabilities now, as well as their potential for the future.

NETWORK CONSIDERATIONS

Christopher S. Protz
Mosley High School

Abstract

The question of whether to put software applications on the network or on the client computer was studied. Situations were examined, and more questions arose than answers. How many users needed the application became an important question. Other areas that were considered were administration, economics, and performance. It was determined that each application and site should be considered separately.

AN ANALYTIC CAPABILITY FOR PREDICTING STABILITY OF LIQUID SUPPLY SYSTEMS

Steve G. Pugh
Shelbyville Central High School

Abstract

An analytical simulation for predicting stability in liquid supply systems was demonstrated through application to the cryogenic liquid rocket engine propellant supply system proposed for test cell J-4 at AEDC. The simulation is a collection of separate codes capable of predicting low, intermediate, and high frequency instability. Low frequency instabilities, also known as chugging, originate due to coupling between the feed system and the liquid rocket engine. This study was focused toward simulating low frequency stability of the propellant supply system. Overall system admittance, pressure transfer function, and stability were calculated for a range of propellant supply system and liquid rocket engine (LRE) operating conditions. The proposed propellant supply system and liquid rocket engine used for this study were based on existing design drawings and the RL10-3-3A, respectively. Results from the simulation indicate that the liquid oxygen and liquid hydrogen propellant supply systems are unconditionally stable.

POWER SYSTEMS ANALYSIS

Kristopher Stephen Ray
Shelbyville Central High School

Abstract

A power system analysis was performed on the Plenum Evacuation System. Field data and manufacturer's data were collected to support this effort and a database program was created to manage the information.

USING IMAGE PROCESSING PROGRAMS
TO AID SPACE TO GROUND SATELLITES

Paul A. Rodriguez
Santa Fe High School

Abstract

The use of image processing to prepare the data for space to ground satellite neural networks was studied. Image processing requires computers, so the computer language C was studied. Image processing programs were created using the knowledge of C. Possible applications for these programs were developed concurrently with creation of these programs. These applications include sharpening of unfocused images, extracting the edges of objects in the images, and reducing the amount of noise an image may contain.

PAC vs. Area Methods of Determining "Learnability"

Scott E. Sadowski
Centerville High School

Abstract

This paper reports on creating different ways of awarding merit to learning algorithms. The methods discussed in this paper both have positive and negative aspects. They are not eqivalent in performance, except under certain conditions.

QUANTUM WELL INFRARED DETECTOR RESEARCH

Raúl H. Sánchez
Centerville High School

Abstract

Different infrared detectors for various applications were tested. They underwent different tests such as: spectral response, dark current, blackbody response, and noise measurements. The tests were done at different conditions, with several detectors from each sample tested. The detectors were tested for: a high temperature data study, a dark current study, and a study to determine their quantum efficiency.

THE LEARNING OF HYPERBARIC MEDICINE

Rebecca J. Scheel

Abstract

The summer on Brooks Air Force Base, San Antonio, Tx., was spent learning about the backbone functions needed to run a hyperbaric medicine clinic. Aspects such as clinical care, experimentation, and administration were encountered. There was no understanding of this division of Aerospace Physiology when the term began but a comprehensive knowledge was acquired over the course of the eight weeks.

PROJECTS IN THE NONLINEAR OPTICS BRANCH OF THE PHILLIPS LABORATORY

David M. Schindler

This summer during my second tour at Phillips Laboratories I worked on a couple of interesting projects. Phillips Labs has an equipment account called the PMEL (Precision Measurement Equipment Laboratory) account. The people from PMEL have a list of all the equipment that the lab owns and when each piece needs to be re-calibrated. The equipment needs to be re-calibrated so no major miscalculations are made that could ruin an experiment totally. Some one from PMEL comes every Tuesday and picks up the equipment that is due for re-calibration. They also leave a list for us to see which pieces are to be picked up next. The section of this job that I worked on was to make it easier to find the equipment to send away. I used an image scanner to take pictures of equipment to put in a book to be able to see what the different equipment looks like. Many people do not know what a function generator, digital-multimeter, or a programmable amplifier looks like; so by having a book of images, it is easier to locate equipment that has to be picked up. The image scanner was interesting because it took a picture from paper and put it on a computer screen. Once on the screen, I can change the contrast, brightness, and put as much of the picture on the screen as I want.

A STUDY OF HYDROCARBON COMBUSTION: STOICHIOMETRY VS. EQUILIBRIUM

Lana Matthews
Coffee County Central High School

Abstract

The combustion of various hydrocarbons with oxygen was studied. By creating a computer program in the FORTRAN programming language to compute stoichiometric data and by using TEP (Thermo-chemical Equilibrium Program) to provide data at chemical equilibrium, data from combustion of methane, ethane, propane, butane, ethylene, and acetylene with oxygen was computed and plotted with equivalence ratio for both lean and rich conditions. For very lean combustion, the stoichiometric temperature agreed with the equilibrium temperature. For combustion near stoichiometric conditions the equilibrium temperature was depressed, due to dissociation of carbon dioxide into carbon monoxide. For very rich combustion, all fuels except methane exhibited exothermic dissociation to some degree. Actually, when plotting temperature with equivalence ratio of acetylene, the equilibrium temperature became much higher than the stoichiometric temperature as the mixture got richer. Considering the multiple bonds in acetylene, the reason for the larger margin was attributed to the exothermic dissociation of acetylene into carbon, hydrogen, and methane in equilibrium. When the mole fraction of carbon dioxide was plotted versus equivalence ratio for the six gases, an unexpected "double hump" in all but acetylene was observed in equilibrium. After further plotting and the consideration of the dissociation of carbon dioxide, it was concluded that the competition for oxygen played the major part in the irregular increase of the mole fraction of carbon dioxide.

A STUDY OF THE PRACTICALITY OF AN AUTOMATED AIRFIELD DYNAMIC CONE PENETROMETER

Steve J. Mattingley
Mosley High School

Abstract

Captain David Weintraub's proposal and prototype for an Automated Airfield Dynamic Cone Penetrometer was studied along with the original Dynamic Cone Penetrometer. An AADCP would reduce manual labor, reduce the time required for testing, and increase the accuracy of the results. However, a more complicated device presents more complicated problems, both in the field and in the Lab. This study was undertaken to determine whether or not Captain Weintraub's AADCP was a practical replacement for the DCP.

DIGITIZING OF TECHNICAL ILLUSTRATIONS

Elizabeth A. McKinley
Tecumseh High School

Abstract

Prior research conducted by the Armstrong Laboratory's Logistics Research Division (AL/HRG) to improve the performance of maintenance personnel concentrated on ways to present technical information in a manner that would improve performance. A specific area in which this research becomes especially useful is the area of Aircraft Battle Damage Assessment and Repair (ABDA/R). AL/HRG has developed an assessment tool to aid in the ABDA/R process, and the users have responded favorably to the graphical based presentation of technical information.. In order to provide this graphical presentation of data, it is necessary to convert technical illustrations from paper into digital format. To accomplish this conversion, a process was researched, established, and fine-tuned for converting graphical images from paper to intelligent electronic graphics. Multiple paper technical illustrations were converted to intelligent electronic graphics using this newly established process and presented on the Portable Maintenance Aid (PMA).

A Study of KTA

Sandra R. McPherson
Bishop Brossart High School

Abstract

KTA was studied in order to determine if it can be used in advancing the world of nonlinear crystals. The index of refraction, which is a measure of how light travels through a substance, is a basic characterization done by scientists after a new material is created. A spectrometer is used to record the data and we discuss how the data is taken and analyzed. The index of refraction was measured up to 1.4 microns. Due to mechanical difficulties, it was not possible, to go higher, however, it will be in the near future to enable complete characterization of the material. This research was supported by Air Force Office of Scientific Research, Research and Development Laboratories.

VISUAL INSTRUMENTATION DEVELOPMENT

Benjamin J. Merrill
Bellbrook High School

Abstract

I spent my summer apprenticeship with the Structural Dynamics Branch of the Flight Dynamics Directorate, Wright Laboratory, Wright Patterson AFB. During this time, I developed a data logging program that was needed to periodically sample up to eight channels of data during extended fatigue panel tests. The data was to be sampled, processed, displayed, and written to file. I used LabVIEW's (by National Instruments) graphical programming software package to develop a program that calculates the root mean square value for eight channels of data and displayed these values on real-time strip charts while it recorded this data to file to later be read into any standard spreadsheet software to be recalled and analyzed. This program was also designed and documented to be later modified in similar tests in this facility.

PORTING SPICE 2G.6 TO UNIX

Gary W. Midkiff

Fairmont High School

Abstract

Spice 2G.6 was originally written in fortran and assembly language for VAX-11/780 VMS operating system. However, the VMS operating systems are rapidly being replaced by Unix, and therefore Spice 2G.6 needed to be modified in order to run on Unix machines. Spice 2G.6 was not easily ported over because some of the original subroutines are compiled in VAX assembly language, which is not compatible between the different machines. These subroutines had to be rewritten into a higher level language that would be compatible with many different systems. The C language was choosen to replace the assembly language for the porting of Spice 2G.6 to the SPARC and HP Series 700 computers.

High Altitude Balloon Capabilities and Options

David Mirabal

Abstract

High altitude balloons and tethered balloons are different in many ways and are similar in others. They both must overcome the stresses primarily generated by ground winds at launch or wind shears in the troposphere. Because of high stresses due to ground generated wind shear, launch conditions are therefore usually limited to winds of 5 to 10 knots. Some of the missions which Phillips Laboratory runs are very sensitive and require a smooth ride or at least as smooth as possible. The high altitudes which are required sometimes make a smooth ride very difficult to accomplish. The answers to these problems are new and innovative technologies such as lighter balloon films and more durable payloads. For the tethered balloon, a lighter and stronger cable. The stresses do not isolate themselves to the balloon or its payload. The cable, which can sometimes exceed fifty thousand feet, has its share of stress. The wind at different levels of the atmosphere can blow in completely opposite directions and therefore shears the cable. some alternatives to high altitude balloons are remote controlled aircraft, high altitude self powered dirigibles, and newly developed long duration aircraft powered by energy supplied from microwave transmitters on the ground. These are all possibilities for high altitude surveillance of the battlefield and for high altitude experiments where tethered balloons just would not be feasible.

DEVELOPMENT OF THE PICLL (PARTICLE IN CELL LINKED LIST) PREPROCESSOR

Nicholas Mitchell
Belen High School

Abstract

One technique for modeling a non-collisional plasmas is the particle in cell (PIC) approach. The domain of the problem is divided into spatial cells. The fields and currents within the simulation are approximated at uniformily distributed positions throughout the spatial mesh. The plasma is modeled using a number of charged macro particles. The particles and initial conditions are used to update the fields on the problem mesh. These fields are then used to determine particle motion during one full time step. The PIC algorithm uses this two step process to simulate a plasma. A new three dimensional relativistic PIC code is being developed by the Phillips Laboratory, called PICLL (Particle In Cell Linked List). An important part of the project is the preprocessor that generates PICLL's input file. Before the preprocessor is even used, the spatial mesh is created using a grid generation program like CAEDS by IBM. User input along with the output from the mesh generation program are then used by the preprocessor to generate the following information: cell connectivity, two layers of ghost cells, positions of field values on the spatial mesh, and the required relationships among field values. All of the required preprocessor functionality was accomplished in 3500 line of coding. Significant improvement in preprocessor performance is possible by further refining its algorithms.

A STUDY OF THE ORGANIC REACTIONS OF PHTHALOCYANINES, ALLYLOXY GROUPS, AND WAVEGUIDE MEASUREMENTS OF SPUN COATED SILOXANE-TOLUENE SOLUTIONS

Karthik Natarajan
Beavercreek High School

(NOTE: Unlike most reports which deal with only one project, this report deals with three different projects that were performed this summer at Wright-Patterson Air Force Base Materials Laboratory. Therefore, there are presented here three different abstracts, and the report itself consists of three different introductions, methodologies, results, and conclusions.)

Abstract I

Phthalocyanines with sulfonic acid groups attached were always thought of and considered water-soluble, as a result of these groups. As a result, we attempted to perform a series of two reactions in solution, starting with copper phthalocyanine tetrasulfonic acid. Our first reaction would simply extract the copper out of the compound, leaving metal-free phthalocyanine tetrasulfonic acid, while our second would put lead into this metal-free compound. What we found out while peforming our first reaction was that our copper compound was completely insoluble in water. Upon trying with a nonpolar solvent as well as an intermediate solution, we found similar results. Our conclusion from our analysis showed that in general, phthalocyanines are inert solutes, even with highly polar functional groups attached.

NICKEL-CADMIUM BATTERIES

Julie Ann Niemeyer
Valley High School

Abstract

Nickel-Cadmium battery cells were tested to determine the and condition of the cells and group the cells for satellite use. To test the cells six test stations were established. The testing of the cells was used to condition the cells for use and to also determine the grouping of the cells when used to create batteries. The first station was used to clean and test the cells for any leaks, to take basic measurements, to label the cells, and to apply kapton tape to protect the cells in a space environment. The next were test stations were used to condition the cells in a normal environment. Three stations were necessary to test all batteries in the specified time line and also each station was run and monitored 24 hours a day. The final two test stations were set up on thermal vacuums to test the cells in an environment which the cells will be operating in.

A STUDY OF THE VISCOSITY OF LUBRICATING OILS

Christina L. Noll
Trotwood-Madison High School

Abstract

Lubrication is a very important issue when dealing with the durability of an engine. Lubricating oils, specifically, are studied because of their wide usage. When choosing a lubricating oil, its viscosity is the single most important factor. An oil's viscosity can aid in determining how well that oil will function under certain desired conditions. The viscosities of two separate engine oils are measured at 40°C and 100°C, and at different times (measured in hours). The object of this study is to determine the sustenance of the engine oils by comparing the increase in their viscosities over time.

THE CHARACTERIZATION OF AN ATMOSPHERIC TURBULENCE GENERATOR

Krista Nuttall
La Cueva High School

Abstract

A turbulence generator designed for use in optical laboratory experiments needed to be refurbished and characterized. This was accomplished by: 1) rebuilding the electrical parts of the generator; 2) examining the turbulence produced by the generator using an interferometer; 3) altering the air and heat flow using different methods in an attempt to create homogenous turbulence and determine the equipment's best setting; 4) characterizing specific flow regions of the generator using a laser beam probe, lateral effect sensor, and oscilloscope; and 5) recording the tilt spectrum of the laser beam probe using a spectrum analyzer. The setting that created the most homogenous turbulence was 144W on the heating resistors, fans pulling air out of the generator, and the coarse metal screen placed in the bottom of the tube over the resistors.

SARTING HERE AND GOING BEYOND

Joanna E. Odella
Kettering Fairmont High School

Abstract

I gained knowledge of engineering as a career. Working one on one with engineers of all levels helped me gain understanding of what engineering involves, and what I can expect out of college and my future. I studied the FORTRAN computer language. This knowledge will help me in my computer classes in college. The Antenna Wavefront Simulator was studied. Tests were done on phase shifters to control efficiency with the Antenna Wavefront Simulator. The Simulator is a device which uses GPS (Global Positioning System) technology for research and evalution.

Physical and Chemical Characterization of Columbus Air Force Base Aquifer

Amanda L. Olson
High School Apprenticeship Program

Rutherford High School
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Panama City, Fla 32401

Abstract

A natural attenuation study (NATS) will be conducted on an aquifer in Columbus Air Force Base, Mississippi. A non aqueous phase liquid (NAPL) will be emplaced in the aquifer at Columbus AFB. Soil characterization prior to, and after emplacement of the NAPL is an essential step in monitoring the natural attenuation that occurs. Determination of total organic carbon (TOC) is part of the characterization to be determined prior to the emplacement of the NAPL. TOC analysis and surface area analysis was run on soil samples from the Columbus aquifer. The data obtained during this study is used to test predictive models of the course of natural attenuation. These models will help to determine the fate of groundwater contaminants, make contaminant cleanups more efficient, and help in developing methods for slowing down the spread of these contaminants. In order to make effective groundwater models, other research has to be performed. A sorption study was previously run on aquifers with different material compositions to see if there is any correlation between the composition of the aquifer and surface analysis, total organic carbon percent, cation exchange capacity, percent clay, percent silt, percent sand, and percent iron. The part that this report is concerned with only has to do with total organic carbon percent and specific surface area. If the sorption rate is low, the spread of the contaminants is retarded and natural attenuation tends to take place at a more rapid pace. By knowing total organic carbon and surface area, one would be able to approximate the sorption rate, by means of a simple formula, and therefore determine if natural attenuation would be the most practical means of cleaning a contaminant site. This information could also be used in designing predictive models for contamination cleanups.

Multi-Media- Creation and Uses (Using the MacroMind Director and the NCSA Mosaic)

Michael J. Panara
Rome Free Academy

Abstract

Multi-media and it's importance was studied. To do this the MacroMind Director and the NCSA Mosaic applications were used. The Director was used to create a production, and the Mosaic was used to investigate the different ways in which multi-media could be used effectively to get information across to the user. (Mosaic is a tool that is used to let the user "travel" on the World Wide Web.)

DESIGN AND CONSTRUCTION OF A FLUORESCENCE SPECTROSCOPY EXPERIMENT

Alexander H. Penn
Niceville Senior High School

Abstract

Studied were the fluorescence spectra of Nd:YAG and Nd:YLF. The requirements for taking this spectral data were a working monochromator, a laser diode with all of its support equipment, optics, a chopper and lock-in amplifier, and computer control. The system was set up, calibrated, and succeeded in getting the correct data. Pieces designed for this experiment which may now be used for other experiments include optics for the monochromator and an easy-to-use software interface between it and the computer.

PROJECTS IN THE NONLINEAR OPTICS BRANCH OF THE PHILLIPS LABORATORY

David M. Schindler

This summer during my second tour at Phillips Laboratories I worked on a couple of interesting projects. Phillips Labs has an equipment account called the PMEL (Precision Measurement Equipment Laboratory) account. The people from PMEL have a list of all the equipment that the lab owns and when each piece needs to be re-calibrated. The equipment needs to be re-calibrated so no major miscalculations are made that could ruin an experiment totally. Some one from PMEL comes every Tuesday and picks up the equipment that is due for re-calibration. They also leave a list for us to see which pieces are to be picked up next. The section of this job that I worked on was to make it easier to find the equipment to send away. I used an image scanner to take pictures of equipment to put in a book to be able to see what the different equipment looks like. Many people do not know what a function generator, digital-multimeter, or a programmable amplifier looks like; so by having a book of images, it is easier to locate equipment that has to be picked up. The image scanner was interesting because it took a picture from paper and put it on a computer screen. Once on the screen, I can change the contrast, brightness, and put as much of the picture on the screen as I want.

A STUDY OF A SINGLE TUBE CATALYZED HEAT EXCHANGER

Jill Schlotterbeck
Kettering Fairmont High School

ABSTRACT

A single tube catalyzed heat exchanger was studied. Wright Laboratory and Technology Development Associates Inc. (TDA) developed the single tube catalyzed heat exchanger, which counter flows hot air through the inner tube and methylcyclohexane through the outer tube. TDA also developed the catalyst, which is coated on the external surface of the inner tube. The catalyst and hot air induce the break up of methylcyclohexane into hydrogen and toluene.

DEVELOPING A SOFTWARE ENVIRONMENT FOR A HIGH PERFORMANCE SIGNAL PROCESSOR

Eric J. Hayduk and Richard A. Schneible Jr.

Abstract

A software environment for the FPASP5 (Floating Point Application Specific Processor v 5.0), a high performance signal processor, was developed. As an integral part of this development, the existing software was evaluated. Much of the Microcode and Assembly language had already been written. Still, debugging was required for all levels of the software environment. Further, function libraries had to be written for use by high level language programmers. Debugging consisted of writing test programs in FPASP5 assembly language, assembling them and simulating the programs on a VHSIC Hardware Description Language (VHDL) model of the FPASP5 processor. Results demonstrated that many tested instructions behaved properly and that several others contained bugs which needed to be documented and corrected. When an instruction worked correctly, in many cases, a function library had to be written. Tested instructions and constructed functions are discussed along with the necessary skills to implement this project, problems, corrections, and future steps to complete the development.

THE DETERMINATION OF LEAD IN PAINT CHIPS

Tina K. Schuster
Southwest High School

Abstract

This report descibes the procedure used at the Brooks AFB Occupational and Environmental Health Laboratory to determine the lead content of paint samples. This procedure consists of two main phases: digestion and analysis. Analysis of the paint sample is performed using a Perkin-Elmer Model 303 atomic absorption spectophotometer. Because this instrument can only analyze liquids, the paint chip must be processed into liquid form, or "digested." The resulting sample can then be run through the instrument and analyzed. Both phases will be detailed in this paper.

PREDICTING PERFORMANCE IN REAL-TIME TASKS

Kirk M. Sexton
Northside Health Careers High School

ABSTRACT

This study investigates the correlation between driving simulator performance and Cognitive Abilities Measurement (CAM) tests of spatial working memory and spatial processing speed, and the correlation between simulator performance and average speed in the simulator. Subjects took a week long battery of cognitive abilities tests, which included the spatial working memory and spatial processing speed tests. Subjects also took a fifteen minute driving simulator test. Results showed non significant correlations between driving simulator performance and the CAM spatial working memory and spatial processing speed tests. Results did show a significant correlation of 0.48 between simulator performance and average speed in the simulator, suggesting that driving speed affects driving performance. In addition, the mean average speed for males was significantly higher than for females, suggesting that males are more risky drivers than females.

A STUDY OF THE IONOSPHERE

Min Shao
High School Student
Arlington High School

Abstract

The ionosphere is a partly ionized region of the upper atmosphere. It is important to the Air Force because anything that is (radio) signal passing through the ionosphere will be effected by it. The Air Force has both communications and radars that are effected by the ionosphere. At Phillips Laboratory, GPS (Global Positioning System) satellite signals are used to study the ionosphere. Phillips Laboratory has operated stations to receive the signals from the GPS satellites in Shetland ,United Kingdom, Shemya, Alaska, Hanscom Air Force Base, Massachusetts, and Thule, Greenland. The stations at Shemya are being run currently.

THE COMBUSTION OF ADVANCED COMPOSITE MATERIALS

RYAN Q. SIMON
The Combustion of Advanced Composite Materials

ABSTRACT

The burn characteristics of Advanced Composite materials were investigated. The object of the study was to find particle diameter, smoke composition and the relationship between area, heat and mass loss. Product gasses were analyzed and compounds identified using a Fourier Transform Infra Red (FTIR) spectrometer. Particle size was measured using a high powered optical microscope, and was determined to be less than two microns. This was later verified by electron microscopy. The FTIR discovered many compounds in the smoke, most of which were phenol and aniline derivatives. Data was collected using the controlled environment of the UPITT II oven system. The UPITT II was based on an original design pioneered by the University of Pittsburgh and later enhanced by the United States Army. Data was collected using two configurations of the UPITT II system.

The Effect of Humidity on Friction and Wear for M50 Steel Bearings in the Presence of a Linear Perfluoropolyalkyl Ether Lubricant

Robert J Skebo Jr.
Beavercreek High School

Abstract

The effectiveness of a commercial perfluoropolyalkyl ether lubricant (Fomblin Z) was investigated in a controlled environment by maintaining varying temperature and relative humidity using a Cameron-Plint High Frequency Friction Machine. Data was obtained for 50 C, 100 C, and 150 C degree runs with relative humidities ranging from 5% to 100%. Experimental results indicate that lower relative humidities (<20%) in the surrounding bearing environment causes an increased coefficient of fricion and an exponetially larger amount of wear to occur. Friction and wear tend to be relatively low and constant at medium and high humidities.

MOLECULAR MODELING AND EDITING OF DALM HALIDES

Kenneth B. Spears
Highlands High School

Abstract

A molecular computer model of diazoluminomelanin[1] (DALM) was loaded into a computational chemistry program. The halides of this molecule were to be substituted with halogen atoms to examine how the molecules form and shape would change. When all of the halides were replaced by Iodine, most of the biggest changes occurred.

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[1]Dr. J.L. Kiel, Armstrong Laboratory, Brooks A.F.B., San Antonio, Texas 78235

A STUDY OF THE VISUAL TESTS PERFORMED ON AIR FORCE PILOTS

Courtney Ann Sprague
Southwest High School

Abstract

The visual tests performed on pilots in the Air Force play a vital part in determining whether or not a pilot will be qualified for flying status. Pilots must have excellent eyes in order to retain their vision under strenuous conditions. Continual observation was done to fully understand the method for performing certain tests. Further research was done to determine the possible defects the eyes might have based on the results of the visual tests.

MY INTRODUCTION TO THE INTERNET

Jennifer A. Starr
student
Trotwood Madison Sr. High

ABSTRACT

This report will explain the knowledge obtained, while working at Wright Patterson Air Force Base. It will explain the information acquired about Internet, and its useful functions. In addition, this report will discuss my experience with Internet.

THE EFFECT OF TEMPERATURE UPON Ho:$YAlO_3$ FLUORESCENCE

Todd Stockert
Centerville High School

Abstract

The trends and mechanisms of temperature variant Ho:$YAlO_3$ upconversion were studied. The crystal was pumped with a chopped Ti:sapphire laser beam and the emissions were monitored with a spectrometer. The temperature of the crystal was varied from 19 to 325 K. Previous work with holmium crystals indicates mechanisms of two step upconversion with phonon emission. The present studies conducted with Ho:$YAlO_3$ followed the same pattern. Temperature effects upon spectral excitation, excitation time, and relaxation time indicated a strong influence of temperature. Findings were attributed to the Boltzmann effect. The studied trends suggest maximized intensity for Ho:$YAlO_3$ 543.5 nm emission at around 250 K.

HIGH TEMPERATURE / HIGH SPEED LASER PROJECT

David B. Storch
Beavercreek High School

Abstract

Experiments were conducted into the fabrication of a semiconductor laser device for use in an all-optical backplane. Semiconductor material was grown by Molecular Beam Epitaxy (MBE) and then patterned with an optical lithographic process. Numerous variations in growth procedures and in the patterning process were made to develop a laser that would meet the specified requirements.

DYNAMIC TESTING of COMPOSITES

Christopher Sutton
High School Apprentice
Jefferson High School

Abstract

During my apprenticeship data was collected from targets that were tested at a gun range to see how different structural composites react to various weapons. The resulting damage to the composites was recorded in pictures and Cscans. Over 650 composites were tested. Part of my responsibility was to accumulate and record the new data and make sure everything was correct. This gave me access to new tools, state of the art technology and software, an engineering atmosphere, and an experience unique to any high school student in the world. It was an honor to participate in this apprenticeship program.

ADESH as a Sample Generator for mdem

Nathan B. Terry
Clinton Sr. High School

Abstract

ADESH (Atomistic DEfect Simulation Handler), developed by CASA (Center for Simulations and Analysis), has been found here to be a very useful tool for providing the mdem (molecular dynamics electromigration) simulator with polycrystalline samples. The main reason for ADESH's success at providing mdem with samples is its versatility. Such versatility allows a variety of polycrystalline cells to be created for the mdem system. Creating the methodology to use ADESH as a sample generator for mdem is very critical as mdem cannot generate complex samples. Thus ADESH will prove to be an integral element for the mdem system.

The Physical Significance of the Eigenvalues in Adaptive Arrays

BRIAN P.V. TESTA ,
Rome Laboratory
VINCENT C. VANNICOLA ,
Rome Laboratory

Abstract

We describe the physical significance of the eigenvalues associated with an adaptive antenna array. We also show how the eigenvalues are affected by the power output of the noise sources, the location of the noise sources, and the spatial configuration of the array antenna. The model used to show these relationships consists of two array elements and two independent noise sources located in the far field. We show how the eigenvalues of the covariance matrix vary with the angle of incidence of the noise sources.

Development and Testing of a Two-Dimensional Finite Element Hydrocode

Randy Thomson

High School Apprentice

Abstract

One of the tasks of Wright Labs Armament Directorate, including MNSA, is to design and improve hydrocodes for use in modeling a variety of impact phenomena. One of the main ways that this is accomplished is by adding new material models, failure models, and equations of state. Normally, these models under development must be inserted into a large hydrocode such as EPIC for examining the models' validity. However, this has inherent difficulties. The sheer size, modularization, vectorization, and similar attributes of the EPIC hydrocode make this problematic. Additionally, the EPIC architecture was made highly parallel, which leads to greater efficiency on vectorized supercomputers, but efficiency is drastically reduces when the program is run on a computer of lesser power that is not highly parallel. In fact, it is incredibly difficult and sometimes impossible to run these programs on a x86 personal computer. A need was seen for a smaller, simpler, portable, user-friendly and easily customizable program to use in testing new models. During the summer of 1994, research was conducted to fulfill these requirements, and the resulting hydrocode is the basis for this report.

A STUDY OF INFRARED DEVICES AND RADIOMETRIC MEASUREMENT TECHNIQUES

RAUL TORREZ
SANDIA PREPARATORY SCHOOL

ABSTRACT

This summer's research was centered primarily upon the recent technology developed in the field of infrared detection, as well as the different means of testing the overall performance of that technology. The work was carried out at the Infrared Device Laboratory, a branch of the Passive Sensors department of Phillips Laboratory, on Kirtland Air Force Base.

The work done this summer involved the extensive testing of Quantum Well Infrared Photodetectors or QWIPs. Unlike Photovoltaic devices, QWIPs are a more recent development in the field of thermal detection and are as yet still experiencing some of the quirks expected in newer technology. The two main testing procedures involved in the screening of this type of device are spectral analysis and optical or noise analysis. Both methods of testing provide critical information regarding the efficiency of the device and reveal information about its overall performance. Spectral and optical tests are the radiometric measurement techniques which enable one to discern the elements of a detector that optimize performance and ultimately lead to further advances in the field of thermal detection.

CHARACTERIZATION OF OPTICAL FILTERS BUILT USING SYNTHETIC IMAGERY

John W. Vest
Niceville Senior High School

Abstract

This research project had two primary goals. The first of these goals was to become familiar with the Irma modeling software to prove that it could be used by someone with little or no engineering experience. The second goal was to make two test sequences of images that can be used to make optical filters. To accomplish the first goal, a "movie" was made using Irma and a F-16 facet model. These images were animated at real time speed and transferred to video tape for viewing. Two sets of images were also created for the optical filter test sequences. T-62 and a F-16 facet models were used to make these images. All of these images were made around a 360 degree rotation at a 20 degree elevation. These images were also animated and transferred to video tape.

WHICH IS A BETTER SLEEP SCORING DEVICE FOR OPERATIONAL USE ? ACTIGRAPHS VS. LOGS

Jonathan S.Vinarskai
Castle Hills First Baptist Christian School

Abstract

This study compared the activity monitoring device (actigraphs) with subjectively scored log sheets (logs) in terms of the information the techniques provide that would be useful to monitoring the sleep/wake cycles of operational Air Force personnel. It is important for investigators involved in assessing fatigue due to long duration missions or transmeridian travel to have a reliable technique that can accompany the crews. Subjects in the study were 10 healthy male and female laboratory personnel who participated during July of 1994. The study was conducted under more carefully described situations than could be done in the field in order to more accurately compare the two techniques.

The subjective logs and actigraphs were comparable in scoring time asleep and time awake during the 3 days study. The biggest difference between the two techniques was in average sleep times since the average log sleep time was about 8.5 hours per night and the average actigraph sleep time was about 6.25 hours per night. The logs recorded an average wake time of 17 hours and the actigraph of about 15 hours. Overall, the actigraphs had more variability across days which was taken to mean they were more sensitive to a greater range of sleep/wake times than the logs.

There are many similarities in the data collected by both techniques. For example, in measuring sleep onset, duration. However, the actigraphs had a resolution of about one minute whereas the logs resolution was about 30 minutes. The actigraphs were hampered by occasionally scoring daytime sedentary activities as sleep. However, this could be the algorithm used. The logs were weakened by being time consuming and subject to human memory errors. There are some data that is unique to each method. For example, the logs can record oral temperature and fatigue scores. The actigraphs are unique in the ability to record peak and trough activity periods unobtrusively.

The actigraph may offer the most important advantage in recording sleep/wake data in that it is objective where log entries are subjective. In addition, the logs are associated with a certain amount of human error that does not come into play with actigraphs. However, both techniques ultimately provides data that compliment each other and, if possible, both should be used in operational field research.

Data Acquisition, Reduction, and Storage Using LabVIEW and the Tektronix RTD 720A Digitizer

Jon R. Ward
High School Apprentice
Instrumentations Branch
WL/MNSI

Abstract

A virtual instrument (VI) created using LabVIEW was created which automates data acquisition, data reduction, and data storage. Current data acquisition must be done by manually setting digitizers. Using the program created, the computer communicates with the digitizer via GPIB card and can set vertical mode, channel settings, trigger settings, and data acquisition settings. Then the virtual instrument acquires the data, which may be read and/or stored onto disk. This program was used in the evaluation of a prototype fiber optic air blast pressure sensor and in polyvinylidene fluoride stress sensor validation experiments.

Christian G. Warden

1.1 Introduction to Electric Propulsion

Electric propulsion has been present since the first orbital flights. The first arcjets were low power and run on hydrazine. They were mainly used in commercial applications aboard communication satellites.

Electric propulsion can be summarized as "the acceleration of gases for propulsion by electrical heating and/or by electric and magnetic body forces" [1]. Three categories of electric propulsion have been defined. The categories are *electrothermal, electrostatic, and electromagnetic.* First, electrothermal propulsion uses propellant gases that are electrically heated and expanded through a nozzle to obtain thrust. Electrostatic propulsion uses electricity to ionize propellant gases. The ions are accelerated by direct application of electric body forces. Electromagnetic propulsion systems ionize the propellant gases, which are accelerated by internal and external magnetic fields with electric currents driven through the ionized propellant stream.

COMPUTER RESOURCE TEAM

Jeffrey D. Warren
Fairborn High School

Abstract

The Computer Resource Team at building 450, Wright-Patterson Air Force Base, Ohio maintains the computational environment for the scientists and engineers who work in the Aeromechanics Division (FIM) of the Flight Dynamics Directorate. The team also obtains the computers and associated resources necessary for the fulfillment of the Division's missions.

MOMENTS AND OTHER PC UTILITIES

Josh A. Weaver
High School Apprentice
Warheads Branch
WL/MNMW
Mentor: Mr. Mike Nixon

Abstract

Over the course of my first summer working at Wright Labs, I completed three main projects under the mentorship of Mr. Mike Nixon. The first task that I was given dealt with the rewriting of a program by the name of MOMENTS, making it easier to use and more suited for today's computing capacity. The second project that I was assigned was the development of a computer program that displays a 3D graphical representation of an converted PATRAN neutral file using simple 2D graphics commands. The third and final project of the summer was developing a finite element mesher for the eventual testing of EPIC's evaluation of structural data.

Software Assisted Component Testing for the Antenna Wavefront Simulator

Gerad M. Welch

Abstract

CNI Concept's Antenna WaveFront Simulator is a complex system with hundreds of components that must be tested to verify that they are in proper working condition. Since this testing is repetitive, several computer programs were written to automate the data collection process. By reading data from the testing device, the HP 8753C Network Analyzer, and storing the results in data files, a faster, more accurate means of component testing is afforded. Two dedicated programs were written to test phase shifters and voltage controlled attenuators, but as a last project for the High School Apprentice Program, a simple scripting language and command line interface were developed as a general purpose interface to the bus.

THE EFFECTIVENESS OF HYPERBARIC OXYGEN THERAPY IN ENHANCED WOUND HEALING

Zachary James Westbrook
Somerset High School

ABSTRACT

The effectiveness of hyperbaric oxygen therapy in the treatment of soft tissue infections, crush injuries, thermal burns, and non-healing diabetic skin ulcers was studied. Enhanced wound healing is achieved through the pressurization of a patient at depths of forty-five feet below sea level or more while breathing pure oxygen at intermittent periods of time. This increases the amount of oxygen that is available to the blood and surrounding tissues, thus greatly increasing growth and diminishing the periods of time required for healing.

UTILITY OF INTERNET BASED INFORMATION SYSTEMS IN AIR FORCE LABORATORIES

Thomas E. Whalen
Carroll High School

Abstract

Applications of the Internet and their relevance to Air Force laboratories were investigated and their relative strengths and weaknesses were evaluated. Information for both those new to the Internet and experienced users was researched, and the Internet is explained in simple terms.

Laser Speckle MTF Test Automation and Characterization

Gabrielle L. White Wolf
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Electro-Optics Branch
WL/MNSI

Abstract

The characterization of a camera is necessary to determine the efficiency of the images to be captured; one of the various ways for characterization is with the use of laser speckle. The camera is set up to receive the image projected by a laser, with the use of an integrating sphere, directed through a double-slit aperture. Certain specifications determine the position of the camera and images are acquired at these specific distances. A Fourier Transform is taken of these images and the FFT graphs are used to create a MTF curve. The slope of the curve, as well as its amplitude, can be examined to determine the accuracy of the camera.

Because of the lengthy mathematical equations and the preciseness required to position the camera at specific distances, automation of this process is extremely beneficial for concise examinations of cameras. Automation is even more advantageous when numerous cameras are required to be characterized. With the use of a supplementary program on LabView and the DCI8000, an automated positioner, a procedure based on automation was developed that characterized a KODAK Megaplus camera, Model 1.4, and has the potential to further accurately characterize additional cameras.

DESIGN OF SPECTROSCOPIC MATERIAL-CHARACTERIZATION EXPERIMENTS FOR THE DEVELOPMENT OF EYESAFE SOLID-STATE LASERS

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Center for Research in Electro-Optics & Lasers (CREOL)
University of Central Florida

Abstract

The Laser Radar Research Facility in the Sensor Technology Branch of Wright Laboratories Armament Directorate, Eglin Air Force Base, is researching the development of eyesafe solid-state lasers for use in many military and commercial applications. A fundamental part of this research is the investigation of energy transfer between various rare earth elements (i.e. Thulium and Holmium) in laser hosts. This paper reports on basic laser principles and the early design stages of these experiments.

Design of Testing and Debugging Software for C31 NPE Board

W. Anthony Alford
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Department of Electrical and Computer Engineering

Abstract

The design of diagnostic routines and a monitor program for the C31 NPE board is discussed. The operation of these programs are described, and their performance evaluated.

A THEORETICAL STUDY OF LITHIUM AND MOLTEN SALT GRAPHITE-INTERCALATES

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Department of Chemistry & Geochemistry
Colorado School of Mines

Abstract

A theoretical study was performed to design a method for predicting intercalation behavior of room temperature molten salts into a graphite lattice. The molten salt examined was 1-ethyl-3-methylimidazolium tetrafluoroborate (EMI-BF_4). The graphite sheet system was modeled on a workstation using MOPAC 93 to observe potential structural changes in the graphite and/or the molten salt following an intercalation process as well as any molecular orbital interactions between the graphite and the salt. The modeling of the graphite sheets used the much studied lithium intercalated graphite (LIG) as a benchmark. The results indicate that the complex graphite system can be modeled simply and effectively using semiempirical methods to study the intercalation-deintercalation behavior of ions.

RELATION BETWEEN DETECTION AND INTELLIGIBILITY IN FREE-FIELD MASKING

Robert H. Gilkey
Assistant Professor
and
Jennifer M. Ball
Graduate Research Assistant
Department of Psychology

ABSTRACT

Experimental and theoretical studies are investigating spatial hearing by measuring signal detectability and speech intelligibility in the free field. The research emphasizes the impact of interfering auditory stimulation on spatial hearing performance. Studies that examine the detectibility of signals as a function of their spatial relation to a masker will be used to predict the intelligibility of masked speech. The frequency-dependent role of specific acoustic cues for mediating detection and recognition performance will be addressed. This research will have direct relevance for basic science by delineating the acoustic cues and potential mechanisms underlying spatial hearing phenomena. The results will also have relevance to the design of auditory displays and virtual realities by specifying how the spatial distribution of sounds influences the ability of listeners to detect and understand auditory signals.

TRANSFERRING TECHNOLOGY VIA THE INTERNET

Rolf T. Wigand, Slawomir J. Marcinkowski and John Carlo Bertot
School of Information Studies
Syracuse University

Abstract

The current global economic climate is such that a nation acquires and maintains its wealth, prosperity, and strength predominantly through trade. It is necessary, but no longer sufficient, for a nation to possess a strong military function in a global marketplace. This new emphasis on national competitiveness in trade places Rome Laboratory, as well as other federal laboratories, at an important crossroads. On the one hand, a military advantage requires continual technological superiority. On the other hand, Rome Laboratory needs to facilitate national economic development through the transfer of its technologies into the marketplace. These developments serve to highlight the importance of a proactive technology transfer process within Rome Laboratory. However, a proactive operation is difficult to put into action without forthcoming budgetary and personpower increases. This study focuses on a low-cost alternative: to use MOSAIC on the Internet and the World Wide Web to promote the transfer and commercialization of technology. An electronic system was developed allowing access on various technology transfer information and databases to the private sector, as well as Rome Laboratory and other Air Force and public sector users. This report describes these efforts, underlying reconceptualizations, design and implications of the electronic system.

THE EFFECTS OF SOCIALIZATION ON VOCATIONAL ASPIRATIONS OF MIDDLE SCHOOL CHILDREN

Richard G. Best
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Southwest Missouri State University

Abstract

According to labor forecasts for the period from 1990 to the year 2000, the demography of the work force will change such that women will constitute 60% of new entry level workers, while minority groups will account for approximately one third of the total labor force (Offerman & Gowing, 1990). Research indicates that childhood socialization may serve to perpetuate stereotypes restricting vocational development for members of these groups. Consequently, occupational preparation for tomorrow's replacement work force is typically at a disadvantage. In response to this concern, the Armstrong Laboratory has developed plans for an automated, career counseling and exploration system (**ACCESS**) designed to enhance vocational knowledge of middle school children. An assessment component matching the student's interests and abilities with consonant job prerequisites will be integrated into the system. The purpose of the current research was to provide a theoretical foundation investigating anticipatory vocational socialization, defined by Jablin (1987) as vocational development prior to organizational entry. While Jablin considered vocational socialization as a two phase process, consisting of 1) vocational choice/socialization; and 2) organizational choice/entry, the current framework concentrates primarily on vocational choice socialization. The resulting product from this research was a survey designed to identify vocational knowledge of middle school children influenced by socialized expectancies and limitations imposed by social policy (see Figure 1).

THERMAL STABILITY APPARATUS DESIGN AND ERROR ANALYSIS FOR MEASUREMENTS OF ELECTRO-OPTIC POLED POLYMERS

Joseph L. Binford, III
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Electro-Optics Program
University of Dayton

Abstract

We designed and built a temperature-controlled environment for studying the thermal stability of poled electro-optic polymers. Our temperature-controlled chamber allows easy optical access to the sample and will maintain a constant temperature (±5 °C) up to 300 °C. In addition to monitoring the decay of the nonlinearity at various temperatures in this apparatus, we may also use it to pole polymers that must be aligned and cured at the same time. We give preliminary results showing the decay of the electro-optic signal at 150°C for a Dow Corp. poled-polymer sample. We also completed an error analysis that shows how small deviations from the ideal experimental setup can alter the measured electro-optic signal and thus the coefficient r_{33}. The standard method for studying the electro-optic coefficients of poled-polymer samples is the reflection technique originally discussed by Teng and Man.[1] We studied errors in the determination of r_{33} that result from deviations from their ideal setup. We found that uncertainties in the incident angle contribute the greatest error (−3.87% error per degree of deviation). This analysis will help improve the accuracy in measuring the electro-optic coefficients of poled-polymer films.

INFLUENCE OF MODEL COMPLEXITY AND AEROELASTIC CONSTRAINTS ON THE MULTIDISCIPLINARY OPTIMIZATION OF FLIGHT VEHICLE STRUCTURES

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The University of Dayton

Jonathan A. Bishop
NSF Graduate Research Fellow
School of Aerospace and Mechanical Engineering
University of Oklahoma

Abstract

This investigation focused upon the structural weight optimized design of two finite element models of a fighter-type wing of low aspect ratio using ASTROS. The optimal redesign of a fighter wing with the wing structure represented by a coarse and a complex finite element model is obtained with constraints imposed on strength, control reversal, and flutter using both subsonic and supersonic aerodynamic theories. The results from the two wings are comparable for flutter analysis; however, the results differ somewhat for control reversal. The reasons for this difference are investigated. Further study of both wings using different design variable schemes is also conducted.

Effect of Dissolved Gases on the Discharge Coefficient in a Single-Orifice Injector

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Department of Aerospace Engineering and Engineering Mechanics
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Abstract

The effect of dissolved gases on the discharge coefficient in a single-orifice injector was studied. The high pressure cold flow chamber at USAF Phillips Laboratory was used to accumulate the experimental data. Discharge coefficients were measured for injector ΔP's of 0 to 100 psi and a variety of system configurations. Experimental results show that the orifice discharge coefficient has a dependence on the dissolved gas concentration in the working fluid (demineralized water in this case). As the dissolved gas concentration increases, the orifice discharge coefficient also increases. The effect is greater at lower orifice flow rates and seems to have no effect when the flow is cavitating at the higher ΔP's. The orifice discharge coefficient was found to be very dependent on the dissolved gas concentration in the working fluid.

TOWARD MODELING HIGHER LEVEL CONTROL SYSTEMS:
INCLUDING MEMORY'S PLACE IN LEARNING

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Grand Canyon University

Abstract

For the past few summers Dr. Thomas Hancock and Dr. Richard Thurman have been investigating Perceptual Control Theory (PCT). It has been the desire of Dr. Hancock to use the variables from a drill program Dr. Thurman designed to produce a more precise cognitive model of a learner. This study looks into possibilities for such a model.

Through self-reports during the drill program, investigation into current non-PCT models of memory processing and the creation of flow chart models a PCT model was initiated. In the self reports phase it was found that the drill subject had a high level of awareness of strategies used to learn the material. As well, a link between certitude rating and the speed and clarity of items retrieved from memory was observed.

After the self-reports had been completed three flow chart models were attempted. These flowcharts use a non-traditional PCT approach of looking at memory. Memory is viewed as a network which is being operated on by a hierarchy of control systems which brings perceptions from memory into a match with perceptions of the subject's environment. The models of Stephen Grossberg and John Anderson had a key role in the design of these flowchart models.

As well as a description of the trials made in this study, some suggestions toward future studies are made.

THE USE OF PRESSURE SENSITIVE PAINTS ON ROTATING MACHINERY

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Abstract

The current work involves measuring the surface pressure on a rotating blade with a laser scanning pressure paint system. The pressure paint consists of a fluorescent molecule which is mixed with a polymer than painted on the surface of interest. The laser is scanned across the model surface which excites the fluorescent molecule. The intensity with which the molecule emits light is dependent on the amount of oxygen quenching. If the pressure is low the molecule will emit a more intense light then if the pressure were higher. As more oxygen molecules are present they absorb the energy that would have been emitted as light. The system can be calibrated in two ways. The first would be to take an intensity reading with the known pressure and then take a reading at the condition of interest. Then the Stern-Volmer relationship of intensities can be used to calculate the pressure. A second way is to measure the decay time of the emitted intensity and calibrate that versus pressure. The purpose of the experiment is to get a complete surface map of the pressure on the rotating blade.

GAIN-SCHEDULED BANK-TO-TURN AUTOPILOT DESIGN USING LINEAR PARAMETER VARYING TRANSFORMATIONS

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The University of Texas at Austin

Abstract

This paper presents a gain-scheduled autopilot design for a bank-to-turn (BTT) missile. The approach follows a recent design for a longitudinal missile autopilot. The method is novel in that the gain-scheduled design does not involve linearizations about operating points. Instead, the missile dynamics are brought to a linear parameter varying (LPV) form via a state transformation. An LPV system is defined as a linear system whose dynamics depend upon an a priori unknown but measurable exogenous parameter. This framework is applied to the design of a coupled longitudinal/lateral BTT missile autopilot. The pitch and yaw/roll dynamics are separately transformed to LPV form, where the cross axis states are treated as "exogenous" parameters. These are actually endogenous variables, so such a plant is called "quasi-LPV." Once in quasi-LPV form, a family of robust controllers using $\mathcal{H}^\infty$ optimal control is designed for both the pitch and yaw/roll channels. In both cases the scheduling variables are angle-of-attack and roll rate. The closed-loop response to step commands are simulated with the original nonlinear model.

SYNTHESIS & CHARACTERIZATION OF LANTHANUM PHOSPHATE SOL FOR FIBER COATING

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Abstract

Varies routes to synthesize lanthanum phosphate sol have been explored. Thus powdered lanthanum phosphate sol were characterized using powder x-ray diffraction (XRD) and differential thermal analysis/thermogravimetric analysis (DTA/TGA). Appreciable crystallization of lanthanum phosphate ($LaPO_4$) was observed above 400 °C and the average crystallite sizes were calculated as 150 Å, and 460 Å after heat treatment at 700 °C and 1100 °C respectively. Dip coatings of $LaPO_4$ onto sapphire fibers were carried out. The coated fibers were calcined at 1100 °C and examined using scanning electron microscope. The thickness of the coating ranged 60 to 150 nm depending upon the sol concentration and number of dip-coating. XRD of coated fibers revealed the formation of $LaPO_4$ after heat treatment above 700 °C.

FURTHER EXPLORATIONS IN EPISTEMOLOGICAL SPACE

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Abstract

An earlier claim made by Chitwood & Tweney (1993) was tested, specifically, that the epistemological environment encountered by Michael Faraday (1891-1867) in the course of his successful investigation of the properties of electromagnetic induction, was sufficiently "chaotic" such that Faraday must have used something equivalent to a confirmation heuristic. That investigation utilized standard back-propagation neural networks, which, when trained with vectors representing components of 54 of Faraday's experiments, were unable to learn the vectors representing the outcomes of those experiments. The present study explored four variations of network types and configurations in efforts to disconfirm the prior claim. Despite numerous manipulations of network parameters, none of our network instantiations led to successful learning when all 54 experimental representations were included in a training set, although when the "null" outcomes (those in which Faraday did not achieve an effect) were excluded from the training set the networks could learn the remaining (i.e. "confirmatory") outcomes quite well. Converging results from each network instantiation suggest that Neural Networks are promising tools for the exploration of the epistemological properties of scientific work. In particular, examinations of the results of our final network manipulations which utilized a Kohonen self-organizing algorithm, while incomplete, support our stance that "epistemological space" is a very important notion towards a cognitively based understanding of successful scientific endeavors. Other areas of expertise (e.g. piloting) may also be appropriate for Neural Network examination.

PROCESSING AND CHARACTERIZATION OF NONLINEAR OPTICAL PBZT FILMS

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Abstract

Solutions of poly (p-phenylene benzobisthiazole) (PBZT) in methane sulfonic acid (MSA) were prepared. Viscosities of the less concentrated solutions were measured by dilute solution viscometry. Viscosities of the more concentrated solutions were determined with a Rheometrics Dynamic Spectrometer (RDS) model 7700 cone and plate rheometer. The dependence of viscosity on strain rates was also recorded. A plot of viscosity versus concentration was constructed for the entire range of concentrations. Thin films of PBZT were spun on glass slides and silicon wafers using a spin coater for purposes of wave guiding. Since the thickness of the film is a controlling factor in wave guiding, the thicknesses were probed using a profilometer. Studies are still in progress to correlate the thickness of the films directly to the concentrations of the PBZT solutions.

AURALLY DIRECTED SEARCH: A COMPARISON BETWEEN SYNTHESIZED AND NATURAL 3-D SOUND LOCALIZATION ENVIRONMENTS

John E. Cisneros

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University of California at Riverside

Abstract

The present report describes the first two experiments of an extensive series that are currently being conducted on the application of spatial information derived from auditory signals upon visual processing: more specifically, this research investigates the impact of acoustic information upon a human subject's ability to locate and identify visual targets (maintenance of situational awareness). The results of the first experiment confirmed earlier reports (Perrott, Saberi, Brown and Strybel, 1990) that aurally directed visual search was substantially more efficient than unaided search even when the field to be scanned extended a full 360 degrees in azimuth and nearly a full 180 degrees in elevation. This baseline experiment was repeated with audio signals presented over earphones (a 3-D synthesized sound field). Performance in the latter situation was essentially identical to that encountered in the free field (i.e., natural environment), especially for visual targets initially located in the frontal hemi-field. These results indicate:(1) that free field listening environments can be generated in obviously non-free field situations (such as a cockpit of an airplane) with little loss in the utility of the derived spatial input and (2) that such information can substantially improve the human subject's ability to process visual information.

INTRA-OCULAR LASER SURGICAL PROBE (ILSP) FOR VITREOUS MICRO-SURGERY

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Abstract

The surgical treatment of many vitreoretinal diseases, involves removal of membranes or vitreous strands overlying the surface of the retina. Instruments currently utilized in this procedure have disadvantages inherent in their mechanical nature. A model laser surgical probe has been designed and built (patent pending) by Lt. Daniel X. Hammer (AL/OEO, Brooks AFB, TX) and Cynthia A. Toth, M.D. (Department of Ophthalmology, Duke University, Durham, NC) to perform cutting of fibrovascular membranes within the vitreous cavity of the eye using laser induced breakdown (LIB).[1] LIB is a process by which atoms are ionized and a plasma of quasi-free electrons and ions is created. The probe consists of a multimode optical fiber, for maneuverability and light delivery, with a gradient index (GRIN) lens attached for micro-focusing. The problematic areas in the development of the probe were examined. These include delivery of high-energy Q-switched 5 ns pulses of 1064 nm Nd:YAG laser through an optical fiber and micro-focusing light energy from fiber to achieve LIB.

FINITE ELEMENT MODELING OF MANIKIN NECKS FOR THE ATB MODEL

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Abstract

The Articulated Total Body (ATB) is a rigid body dynamic model used at Armstrong Laboratory to predict the response of the human body in different environments such as automobile collisions and pilot ejections. In some situations the rigid model does not accurately predict the response. There are segments of the human body and other structures in the simulation that exhibit large deformation effects. A new version of the ATB couples the rigid body behavior with the deformation of the individual segments. The displacements due to deformation can be determined by using finite element modal analysis with models of those segments of interest. This report concentrates on the modeling of manikin necks which have shown large deformation in certain environments. The results of the modal analysis of these necks are to be used in the validation of the new version of the ATB. Hybrid II and Hybrid III manikin neck models and modal solutions are presented here.

ASSESSMENT OF GASP FOR THE SIMULATION OF SCRAMJET COMBUSTOR FLOW FIELDS

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ABSTRACT

An assessment of GASP for predicting SCRAMJET combustor flow fields has been completed. The program was evaluated by comparing numerical solutions with experimental data obtained for supersonic turbulent flow over a blunt base. The turbulence models available in GASP are: Baldwin-Lomax, Lam-Bremhorst low Re number k-ε model, and Chien's low Re number k-ε model. The results revealed that the Lam-Bremhorst low Re number k-ε model provided the most accurate predictions. The Lam-Bremhorst model predicted the wake closure to within 29% and the base pressure to within 36%. The solutions for u, v, and p have also been compared to experiment. A preliminary study of helium injection into a Mach 2 airstream has also been completed. The grid structure, boundary conditions, and problem formulation have been developed. An approximate solution on a coarse grid (≈ 102,000 cells) was obtained to a residual of $4.5(10^{-2})$. The solution on the coarse grid was observed to then diverge. Recommendations for proceeding with the investigation of helium injection into a Mach 2 airstream using GASP are given.

Analysis of Extraction and Aggregation Techniques for Model Construction in Highly Autonomous Systems

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Abstract

In investigating front end model development, an environment is described that allows for model insertion and evaluation. The preformal stages of the model will be represented by an English language verb phrase. This representation is sufficiently detailed to serve as the basis for model construction and yet sufficiently "soft" to support knowledge acquisition during model construction. This paper establishes the adequacy of this representation.

Using Self-Organization to Develop Vector Representations of Text: A Progress Report

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Abstract

This paper presents work in progress towards a flexible and automatic method of generating representations of free text for input to neural networks. A partial algorithm to develop vector representations for words, sentences, and paragraphs with self-organization techniques is introduced. The results are analyzed, problems with the algorithm are identified, and solutions are presented.

A STUDY OF THE HEAT TRANSFER FOR THE HIGH FLUX HEAT EXCHANGER

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Abstract

An experimental study was conducted to determine the heat transfer capabilities of the high flux heat exchanger, using Polyalphaolefin (PAO) as the coolant. This study was completed over a range of coolant temperatures from 0 °C to 40 °C with intervals of 10 °C. Because PAO was used as the coolant this study represents an unique example of the performance of the compact high intensity cooler designed by Sundstrand under laminar flow. Previously, the majority of tests performed on the compact high intensity cooler were for turbulent flow. In addition to the heat transfer capabilities, the study also included the examination of the dynamic pressure drop across the high flux heat exchanger, which has a design point pressure drop of 16 psi at 30 °C and 4.5 kg/min. However, this study shows that the pressure drop is 16 psi at 30 °C and 2.5 kg/min. Further dissimilarities include the predicted thermal resistance and the calculated thermal resistance. For example at 20 °C the thermal resistance was calculated at .22 for a flow rate of 3.5 kg/min. and the predicted thermal resistance was .28 for the same flow rate. However, for a flow rate of 1.5 kg/min., the thermal resistance was calculated at .29 while the predicted thermal resistance was .52 for the same flow rate. These dissimilarities indicate the need for an improved correlation between the hydraulic and thermal performances and the input variables for laminar flow.

PERFORMANCE AND VALIDATION STUDIES OF THE KIVA-II CODE FOR WIND TUNNEL SPRAY BAR DROPLET DISPERSION

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ABSTRACT

A version of the KIVA-II flow code was first analyzed for performance improvements due to acceleration modifications and then compared with an experimental data set for validation. AEDC has sought a computational methodology for robust and accurate prediction of spray bar droplet dispersion for engine icing tests. Previous studies have determined that the most efficient computational methodology would involve a decoupled gas phase computation by the NPARC code, followed by a droplet and vapor computation by KIVA-II. In addition, KIVA-II would be modified to include local timestepping for both the vapor and particle computations to reduce CPU requirements. The present research involved the analysis of CPU time savings based on comparisons of liquid water content (LWC) over time between an accelerated and standard acceleration KIVA-II. These performance studies have shown a significant, yet varying degree of CPU time savings. In addition, a test case with a methanol spray was computed for comparisons with experimental results of an identical case. Initial studies of this validation case indicate a degree of computational accuracy in the vapor phase.

DETERMINATION OF THE OXIDATIVE REDOX CAPACITY OF AQUIFER SEDIMENT MATERIAL BY SPECTROELECTROCHEMICAL COULOMETRIC TITRATION

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and
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Abstract

Methodology was developed for determination of the oxidative redox capacity of aquifer sediment material by the method of spectroelectrochemical coulometric titration. This method involves the measurement of absorbance of sediment particle slurries at the maximum absorption wavelengths of the optically detectable mediator-titrant (reporter) molecules resorufin and methyl viologen as a function of the charge passed in a constant-potential coulometric titration. An approach which was successful for determination of the oxidative redox capacity of a pond sediment rich in organic matter and iron species was extended to an oxidized aquifer sediment material of low organic carbon and iron species content sampled from Columbus Air Force Base, Mississippi. Titration was carried out on diluted, dry-sieved material of particle size smaller than 75 μm diameter, suspended in aqueous, pH 7, 0.1 ionic strength phosphate buffer at 0.0426 % sediment by weight. Blank titration was carried out on a sample of identical composition but in absence of the aquifer material. In both cases, resorufin was reduced first, followed by methyl viologen. There was no perceptible delay between completion of titration of resorufin and the initiation of titration of methyl viologen. This behavior contrasted significantly with the titration of pond sediment of high organic and iron species content, which showed a very significant break between completion of titration of resorufin and initiation of titration of methyl viologen. Based on the uncertainties of measurement, it could be estimated that the upper limit of oxidative redox capacity of the Columbus aquifer material was ca. 3 microequivalents per gram of solid material. This estimate is in the vicinity of the values of redox capacity of aquifer material obtained from other sites by one other research group, but not consistent with the values reported by another group. More precise determination of oxidative redox capacity will require use of methods such as fluorescence which are more immune to the effects of scattered light than absorption spectrophotometry, and will allow higher loading of suspended solids than the current absorbance-based method. Additional studies identified the importance of thermal expansion of aqueous solutions as a cause of oxygen leakage into closed vessels when temperature is not regulated, and demonstrated that huge pressure changes (900 psi over a range of 22 °C) can occur when the temperature of an aqueous sample is allowed to vary by small amounts. Methods were devised to overcome this problem by the combination of a thermoisolation chamber to control the temperature of the sample and exclude oxygen from the titration zone.

ANALYSIS TO DETERMINE THE QUALITY FACTOR OF A COMPLEX CAVITY

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Abstract

The low frequency, preliminary analysis of a simplified model of a space craft sensor has been accomplished using CARLOS-3D™ (Code for Analysis of Radiators on Lossy Surfaces), a general purpose computer code using the Method of Moments (MoM.) Resonances of a cavity region have been identified by determining the cavity quality factor (Q) as a function of frequency. The Q is proportional to the total energy stored in the cavity and inversely proportional to the power lost from the cavity due to lossy materials and apertures. Even though this measure does not give an exact value for power density at a specific point in the system, it does give an indication of the representative power levels one will find in a similar system. An analysis approach for the high frequency range includes using GEMACS (General Electromagnetic Model for the Analysis of Complex Systems) which incorporates the geometrical theory of diffraction, MoM, and the finite difference method for multiple region problems. A comparison of the two methods (CARLOS-3D™ and GEMACS) at an intermediate frequency (~3 GHz) is proposed.

ESTIMATION OF FOUR ARTERIAL VASCULAR PARAMETERS FOR TRANSIENT AND STEADY BEATS

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Abstract

A faster method was developed to estimate four arterial vascular parameters under steady and transient beat conditions. A four element electrical circuit was used as a model for the arterial vascular system. Mathematical development for the impedance of this model was reduced to its real and imaginary components. Fast fourier transforms (FFT) were used on simulated aortic pressure (AoP) and aortic flow (AoF) data to obtain arterial impedance at various frequencies. Using a numerical routine, the four parameters could then be estimated from a best fit solution using both the mathematical equations for impedance and the FFT impedance.

Estimations were done for steady and transient beats. Transient beats were estimated assuming that the transient behavior was a linear ramp due to a low amplitude, low frequency, baseline shift. Results show that this technique can estimate the four parameters accurately for both steady and transient beats. At the same time, this FFT algorithm proved to be a much faster way to estimate these parameters.

Theoretical Investigations of the NLO properties of substituted Acetylenes

Antonio M. Ferreira

Abstract: The Nonlinear Optical (NLO) properties of a series of substituted acetylenes have been studied from a theoretical perspective. Calculations of the polarizability and the first and second hyperpolarizabilities have been carried out using an *ab initio* Time-dependent Hartree-Fock (TDHF) approach with several basis sets in order to evaluate the computational methods involved as well as substituent effects on a class of relatively simple molecules.

Using a search heuristic in an NP-complete problem in Ashenhurst-Curtis Decomposition.

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Abstract

This paper reports on the application of several searching algorithms to Ashenhurst-Curtis decomposition. A final search algorithm is then presented that is base on using different values instead of just using column multiplicity to guide the search. The influence behind this algorithm is the analogous behavior of functional decomposition to decision trees. By using this algorithm 2^N possible partitions can be searched by evaluating $\frac{N*(N+1)}{2}$ partitions.

DIRECTION FINDING IN THE PRESENCE OF A NEAR FIELD SCATTERER

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Abstract

In this paper we consider the problem of computing the directions of arrival of two closely spaced signals when there is a scatterer in the near field of the antenna array. The antenna is a linear array of equally spaced dipoles modeled with the method of moments (MoM). The spacing between the dipoles is $\lambda/2$ so that the coupling between the antenna elements is minimized without permitting the array to form grating lobes. The scatterer is a finite length edge modeled with the Uniform Theory of Diffraction (UTD) and equivalent currents. The edge can have any length and any orientation relative to the antenna array. The coupling between the edge and the antenna array is accounted for in the method of moments by using a hybrid technique that combines the Uniform Theory of Diffraction with the method of moments. The final computer program was validated by comparing a special case with previously published results. It is shown that the edge degrades the Multiple Signal Classification (MUSIC) algorithm's ability to resolve two closely spaced plane waves.

INVESTIGATIONS OF CARBON MATERIALS IN ALKALI METAL BUFFERED CHLOROALUMINATE MOLTEN SALTS

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Abstract

This project involved the electrochemical investigations of carbon electrodes in buffered room temperature molten salts composed of $AlCl_3$, 1-ethyl-3-methylimidazolium chloride (EMIC), and an alkali metal chloride, MCl (M=Li, Na, K). The EMIC/$AlCl_3$/MCl molten salt has several unique properties which makes it a promising candidate for battery electrolytes, including a wide electrochemical window, high inherent conductivity, negligible vapor pressure, high thermal stability, high alkali metal cation concentration, and low alkali metal cation solvation energies. By intercalating the desired alkali metal into a graphite electrode the problems commonly associated with elemental alkali metal anodes are avoided and thus the efficiency and safety of the battery are improved. Carbons investigated in these melts included Glassy Carbon, Graphite Rod, and Graphite Sheet.

ACCURACY CURVES IN A LOCATION-CUING PARADIGM FOR VISUAL ATTENTION

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Abstract

The aim of the study was to investigate the allocation of visual attention in order to differentiate between two general classes of mechanisms: (a) switching attention across locations on different trials, and (b) sharing attention across multiple locations within a trial. A location-cuing method was used to investigate the time-course of attention growth at valid and invalid locations, as a function of cue probability. It was proposed that the accuracy curves produced would be diagnostic of whether a switching or sharing strategy was used to allocate attention over the visual field. The pattern for valid curves differed from the pattern of invalid curves. However, the data did not show a clear effect of cue probability and could not be analyzed for switching versus sharing.

ITS EVALUATION: A REVIEW OF THE PAST AND RECOMMENDATIONS FOR THE FUTURE

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Abstract

Scientists and educators are expecting great things from Intelligent Tutoring Systems (ITSs). Over the past twenty years, many intelligent tutors have been developed. Unfortunately, evaluations of these tutors are scarce and have not supported many of the expectations expressed. Thus, researchers need to critically examine the quality of ITSs, as well as the research evaluating these systems, to learn how system development and evaluation can be improved. The purpose of this paper is to review recent ITS evaluations, examine how ITS evaluation has changed over time, and make recommendations to guide future research. First, the architecture and boundaries of ITSs are defined, and potential instructional, outcome, and administrative benefits are delineated. ITS evaluations are then reviewed and analyzed with respect to their research questions, methodologies, and criteria for effectiveness. Empirical evidence in support of ITS efficacy is summarized. Lastly, recommendations are given to guide future ITS evaluation. In the future, ITS researchers should (1) evaluate factors which contribute to the efficacy of an ITS (2) utilize process measures, as well as wider range of outcome measures, (3) evaluate transfer validity in addition to training validity, (4) consider ITSs from a systems perspective, and (5) utilize a systematic approach for evaluation and development.

OBTAINING THE CORRECTION FACTORS FOR TWO-PHOTON INDUCED FLUORESCENCE COVERING THE Ti:SAPPHIRE TUNING RANGE

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Abstract

A two-photon fluorometer was built using a tunable, single-mode Ti:sapphire laser. Fluorescence excitation spectra obtained using this instrument can be used as a reference to correct for the square of the incident intensity in spectra taken with mode-locked, and some multimode sources. The obvious disadvantage of this instrument was the inherent loss of sensitivity, which was greater than five decades. However, this instrumentation does allow for the collection of two-photon excitation spectra, of molecules with high cross-sections, without noise due to second-order coherence effects.

INTERIOR SPECTROSCOPIC INVESTIGATION OF PLASMA COMPOSITION AND SPECIES PROFILES FOR A 26 kW CLASS RADIATIVELY COOLED AMMONIA ARCJET NOZZLE

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Abstract

In order to better understand the operational characteristics of a 26 kW class ammonia arcjet similar to the one which will be used for the United States Air Force's Electric Propulsion Space Experiment, a study of the plasma inside the arcjet's nozzle was performed using emission spectroscopy. Photomultiplier tube scans and charged coupling device readings were taken through optical access ports located axially along the nozzle/anode. Species found in less than trace amounts were: atomic hydrogen (H), singly ionized atomic nitrogen (NII), molecular nitrogen (N_2), and the NH ion. The Boltzmann plot method was used to determine the excitation temperatures for H and NII. As the plasma expanded within the nozzle, both the H and NII temperatures decreased. At the exit plane, however, the hydrogen temperature increased; a phenomena that may be due to the presence of a barrel shock. In performing these plots, many of the lower energy states were found to be underpopulated and thus not in local thermodynamic equilibrium. Additionally, NII was found to be at a much higher temperature than H, indicating a non-uniform plasma with NII concentrated at the arcjet core while H was distributed throughout the nozzle. Electron number density was determined using a method developed by Griem. The results show a decrease in density in the downstream direction resulting from nozzle expansion and electron-ion recombination. These results agree with number density data from earlier studies carried out on low power arcjets, indicating that the increased physical size of a high power arcjet balances with the increased specific power to keep the number density constant for a given area ratio.

TESTING R-WISE: READING AND WRITING IN A SUPPORTIVE ENVIRONMENT

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ABSTRACT

R-WISE (Reading and Writing in a Supportive Environment) is part of a seven-year Air Force effort--the Fundamental Skills Training Project--to transition the latest innovations in computer-aided instruction to the public schools. This "intelligent" critical literacy skills tutor has been under development since 1991. Currently, two different versions of R-WISE are being tested in ten schools throughout the nation. Offering two different versions--the Lean and the Rich--is necessary to assess how much intelligent advice is optimal for a given student aptitude and teacher style. Results of the 1994-1995 field evaluation will be available in the fall of 1995. My own role as a technical writer has been to create several student and teacher R-WISE user's manuals.

DEVELOPMENT OF A MONITOR FOR A MULTI-PROCESSOR NETWORK

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Abstract

In the course of the development of a new multi-processor C31 (Texas Instruments TMS320C31) computer board, it became increasingly necessary to find ways to communicate with the processors on the board without the use of a JTAG-standard emulator pod (which can be expensive), and without having to constantly reprogram EPROMs every time a program change is needed. It was decided that a daisy-chain loop connecting the host IBM-compatible PC to a network of C31s was the most direct, and simplest way to accomplish this goal. Since each C31 has exactly one serial communication input and one output, wiring the monitor system was simply a matter of connecting serial outputs to serial inputs and connecting the ends of the loop to the IBM PC. A computer program was then developed to interface with all of the C31s in the loop so that at any time, the user could access registers, look at memory locations, and download code or data to any of the processors in the loop. The reader may find several ideas which may be employed in developing his or her own JTAG-independent monitor programs for use with a multi-processor computer system.

DROP SIZING OF A LIKE-IMPINGING ELEMENT INJECTOR IN A HIGH PRESSURE ENVIRONMENT

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Abstract

The effect of gas density and liquid momentum flux on the average drop size of a like-impinging element injector was studied. These effects were studied over a wide range gas densities and liquid momentum flux. Gas density was varied up to 159 kg/m^3, corresponding to a test chamber pressure of 2000 psig. Average drop sizes were measured by a Malvern Instruments Particle Sizer. The Malvern instrument is a laser based optical probe utilizing the Fraunhofer diffraction theory of light to measure particle sizes. Sauter mean diameter, mass median diameter, as well as size distribution are calculated by the Malvern instrument. Correlations for the mean diameters were derived in this study and compared with those available in the open literature. These studies indicate that the average drop size in the spray of a like-impinging element injector decreases with increasing gas density and increasing liquid momentum flux.

RAPID BACTERIAL DNA FINGERPRINTING BY THE POLYMERASE CHAIN REACTION

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Abstract

Typing of bacterial strains by polymerase chain reaction fingerprinting was studied. Bacterial strains were grown overnight and the DNA isolated by the CTAB method. This study utilized REP and ERIC primers, which target dispersed repetitive sequences, for gram negative bacteria (especially *E. coli*, *Salmonella*, and *Pseudomonas*). Primers were derived from repetitive sequences in *M. pneumoniae* and used with the gram positive organism *S. aureus*. Differential fingerprints were obtained by PCR showing which strains were derived from the same bacterial clone.

AN ASSIGNMENT BASED APPROACH TO PARALLEL-MACHINE SCHEDULING

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Abstract

In this paper, we address the scheduling problem of allocating a set of tasks to a set of resources in order to optimize a set of objectives, eg. to minimize tardiness or maximize resource utilization, and while satisfying any given resource capacity or temporal constraints (between jobs, etc). Because this is a known NP-complete problem, we cannot in practice rely on exponential optimal algorithms to solve it. Instead, heuristic approaches are utilized which can find suboptimal solutions in a reasonable amount of time. The novelty of our approach has to do with the way allocation decisions are performed. Unlike some heuristic approaches which make only one resource allocation decision at a time, several decisions concerning multiple equivalent resources and multiple candidate operations are made at a time. Furthermore, the algorithm takes advantage of an efficient assignment algorithm which can handle balancing trade-offs between multiple conflicting objectives.

A RESEARCH PLAN FOR EVALUATING WAVE GUN AS A LOW-LOADING MODEL LAUNCHER FOR HIGH SPEED AEROBALLISTIC TESTS

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and

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Abstract

A specialized light gas gun firing cycle, developed by Thomas Dahm of Astron Research and Engineering and named by him the Wave Gun, is investigated as a candidate for launching models in a ballistic range to high speed with relatively low model loading. The Wave Gun firing cycle features a very light piston which oscillates during the shot and produces a series of shock impulses on the model. A light gas gun interior ballistics code that simulates the Wave Gun firing cycle was used to evaluate launcher performance for a matrix of launcher geometric and launch parameters. A Wave Gun test facility, designed and constructed by Astron, was used to provide data with which to verify the fidelity of the simulation code. Pressure histories were recorded in the combustion chamber, the pump tube exit, the nozzle exit and at three axial stations along the launch tube. In addition the first-pass piston velocity and the model muzzle velocity were determined. Two test shots were fired. During the second shot a nozzle structural failure occurred and further testing was suspended pending fabrication of a new nozzle. The data acquired from the tests were not sufficient to verify the numerical model. However, the tests did provide experience in operation of the gun and data acquisition, and they provided insight into the status of the numerical model and the direction that future testing should take. A plan is presented for numerical and experimental studies to identify parameter sets that produce high velocity with moderate model loading. Initial testing and analysis will be devoted to validation of the gun cycle simulation code. Then parametric studies, supported by appropriate tests, will be carried out. Six parameters identified for consideration in these studies are propellant type and weight, helium charge pressure, pump tube volume, piston start pressure and model start pressure. Launch tube and model configurations will be held constant.

MELATONIN, BODY TEMPERATURE AND SLEEP IN HUMANS: A REVIEW OF A NEW HYPNOTIC DRUG

Rod J. Hughes

Introduction

Recent humanitarian missions to Rwanda and long range tactical missions before and during the Gulf War exemplify the evolving role of the Air Force as it executes its global responsibilities. Global Power and Global Reach efforts require not only that air crew fly extended missions crossing many time zones but also that air crew perform at peak levels at their destination. Additionally, military downsizing threatens to place even more pressure on human personnel. To complete their missions, air crew are often required to establish work-rest (wake-sleep) behavioral patterns that are independent of the solar light-dark cycle. However, while behavioral patterns can be changed quickly, underlying endogenous physiological patterns cannot. The result can be an out-of-phase relationship between behavioral rhythms and physiological rhythms. This out of phase relationship is termed circadian desynchrony. Circadian desynchrony occurs in sustained operations and in operations in which personnel are required to function out-of-phase with their endogenous circadian rhythms (e.g., shift work and rapid transmeridian travel). In these operations, nighttime performance is impaired because physiological rhythms such as alertness, psychomotor abilities and cognitive abilities are not at peak levels (e.g., Åkerstedt, 1988). The fatigue associated with trying to work at night is exacerbated by trying to sleep during the day, out-of-phase with endogenous sleep rhythms. Daytime sleep is more difficult to initiate, is fragmented by multiple awakenings and is truncated (Naitoh, Kelly & Englund, 1990). The combination of working at night and sleeping during the day often leads to serious negative consequences such as impaired performance (e.g., Keran, Smith, Duchon, Robinson & Trites, 1991; Leung, & Becker, 1992) and increases in accidents (e.g., Mitler, et al., 1988; Novak, Smolensky, Fairchild & Reves, 1990). Operating under such desynchrony for many years is also associated with health risks including gastrointestinal disorders and increased risk of cardiovascular disease (Moore-Ede & Richardson, 1985; Naitoh, Kelly & Englund, 1990).

PARALLELIZATION OF CHIMERA UTILIZING PVM

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Abstract

The parallelization of the Computational Fluid Dynamics chimera based flow solver XAIR through the utilization of Parallel Virtual Machine software is described. The required modifications are discussed in a four step process. Efficiency results indicate an almost linear speedup and limited communication overhead for a near perfect test case.

EFFECTIVENESS OF THERMIONIC HEAT PIPE MODULE

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Abstract

The Thermionic Heat Pipe Module (THPM) is a thermionic converter. The design of the THPM utilizes a lithium filled annular heat pipe whose interior annular ring serves as the emitter surface. The annular emitter heat pipe surrounds a lithium filled cylindrical heat pipe whose outer surface is the collector. The emitter heat pipe is radiatively coupled to an exterior heat source. This configuration allows for efficient heat transport from the heat source to the heat rejection system.

This paper characterizes the performance of the emitter heat pipe when a non-uniform heat source is applied. A temperature profile of the emitter surface was recorded through a temperature range of 300K to 2100K. This profile can be used as a baseline for future THPM tests and can be used to verify the accuracy of various models of the emitter heat pipe.

A Numerical Study of the Effect of Base and Collector Structures on the Performance of AlGaAs/GaAs Multi-Finger HBTs

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Abstract

A numerical analysis is presented to investigate different base and collector structures on the dc and ac performance of the AlGaAs/GaAs multi-finger heterojunction bipolar transistor (HBT). The simulation is carried out using a two-dimensional device simulator called MEDICI. Five possible structures are studied and compared. The results show that different structures give rise to different electric fields in the base-collector junction and lattice temperatures in the HBT, which consequently affect the HBT's cutoff frequency and current gain, respectively. The physical mechanisms governing these changes are also discussed in detail.

AUTOMATIC EXTRACTION OF DRAINAGE NETWORK FROM DIGITAL TERRAIN ELEVATION DATA

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Abstract

In this report a straight forward approach for automatic extraction of drainage network from Digital Terrain Elevation Data (DTED) of the Defense Mapping Agency (DMA) is presented. The approach is based on common image processing methods such as frequency domain filtering, spatial domain histogram equalization, binarization, thinning and other techniques. The approach has been examined with several DTED files. The results obtained from this approach are as good as, or better than, other methods. The approach was developed using Khoros image processing system and C programming. Khoros has excellent visually based environment and its rather extensive library of functions helped avoid writing of commonly used codes.

Mutual Coupling Effect of Square Microstrip Patch Antennas on a Ferrite Substrate

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Abstract

This report presents experimental investigations of the mutual coupling effect between square microstrip patch antennas on a ferrite substrate. The experiment measures mutual coupling between elements mounted on thin and bulk ferrites as well as elements in different configurations, E-plane and H-plane. The mutual coupling level decreases over 10dB as the in-plane directed DC magnetic field is applied to the ferrite substrate for elements in both configurations The mutual coupling's dependence on the thickness of the substrate is also discussed.

A SINGLE TEMPERATURE/MATERIAL ABLATION ALGORITHM FOR THE NON-IDEAL MHD CODE, MACH2

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Abstract

Ablation is an important physical mechanism in re-entry vehicle engineering, material processing, and the operation of pulsed (or steady state) plasma devices. The non-ideal MHD code MACH2 has the capability to model ablation of materials, but has areas on which improvements may be made. The three most critical areas are the inclusion of condensation physics leading to zero net mass flux at equilibrium, localized heat fluxes into the wall based upon Fourier's Law, and tracking of the interface between the ablated vapor and the surrounding gas so that the work done by the vapor on the gas can be accounted for. The new ablation algorithm is based upon an equilibrium vapor state. A simple bench-test of the new model was performed for a single material at a single temperature. A one-dimensional, ideal gas, singly ionized copper plasma at 0.50 eV, 1.0×10^{-2} kg/m^3 was pre-filled in a 0.20m x 0.10m x 1.00m closed box free of fields and currents. All walls except one (0.10m) was defined as thermally insulative. The solid copper (thermally conductive) wall, initially at 0.026 eV (300K), served as an ablation surface. Qualitative preliminary results indicate that heat flows into the wall with the proper magnitude and direction. Also, condensation of the warm copper plasma was observed during early times. Interface tracking was not used due to time constraints.

A THEORY FOR THE TESTING OF MATERIALS UNDER COMBINED TENSION-TORSION

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Abstract

This theory for the yielding behavior of materials under combined tension-torsion uses the von Mises yield criteria and accounts for the effects of testing machine stiffness. Experimental results are given for tests performed on 6061-T6 aluminum and a yield surface is constructed from this data. It is concluded that the von Mises criteria may not be totally satisfactory in modelling the yielding response of real materials under multiaxial loading.

ESTIMATION OF TILTS OF EXTENDED IMAGES IN THE PRESENCE OF ATMOSPHERIC DISTURBANCES USING OPTICAL FLOW ALGORITHMS

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Abstract

One of the components of the Air Borne Laser (ABL) system is an optical, infra-red wavelength Acquisition, Tracking and Pointing (ATP) system. This system is to acquire a missile target at ranges of 200–300 km, track this missile target, and then point a High Energy Laser (HEL) at a critical target fudiciary for the purpose of destroying the missile in its boost phase.

To date, the only tracking algorithm examined in the ATP system is a biased centroid algorithm [1]. This report details research into other algorithms useful for tracking which are broadly classed in the literature as *optical flow* (OF) algorithms. The algorithms newly examined for this application were the the Transformed Domain Maximum Likelihood (TDML) algorithm [4] [5], Generalized Maximum Likelihood algorithm (GML) [3], Horn and Schunk's optical flow (HS-OF) algorithm [6], and Fitts' Correlation Tracker (FITTS) [8]. This work presents simulation results from a simulated target image. Comparisons of these algorithms are made to the centroid algorithm. Moreover, the experiments uncovered an interesting and challenging problem with the atmospheric effects on the missile imaging scenario.

The Measurement of Work Experience: Issues and Implications

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Abstract

There has been a wealth of research regarding the effects of work experience on various outcomes. Most of this research has used tenure as the means to quantify experience so that the more organizational or position tenure an incumbent has, the more experience implied. More recent research has provided a framework for classifying work experience in terms of what is done, how often, and for how long. Specific links should be made between the criterion and the predictor, so if one wanted to make specific predictions of the relationship between experience and specific task performance, then one should quantify work experience at the task level. The type of data needed to quantify specific task experience can be obtained through a technique similar to the task or job analysis. However, before a more data-driven quantification of work experience can be implemented, systematic investigations are needed to determine the factors affecting the validity and reliability of this measurement technique. The present paper addresses these issues, reviews the literature regarding the accuracy of work experience ratings, and discusses how this research can apply to personnel selection and the evaluation of training programs.

THREE-DIMENSIONAL MODELING USING A CALIBRATED CAMERA/LASER SYSTEM

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ABSTRACT

Three dimensional (3D) modeling involves combining a laser and camera to form an active range measuring system. The camera receives an object's three dimensional (3D) projection onto its two dimensional (2D) surface, and in the process, loses the object's depth information. By using a laser along with the camera, we retrieve the lost depth information. This camera/laser range measuring system is then placed on a rotating structure (which is an arch) and rotated completely around an object. By obtaining range measurements to an object's surface at many positions around an object, a three-dimensional (3D) reconstruction of the object's surface can be obtained. In order to optimize speed and measurement density, our 3D modeling system uses a non-contact active triangulation method of measuring. In this method, a known pattern is projected on an object using a laser, and its reflection is observed by the camera. Knowing the observed position of the pattern in the detected image, the range to the scene is computed by triangulation methods.

In order to use active triangulation in our system, proper calibration of the camera and camera/laser is essential. By constructing a multi-plane calibration device, we were able to obtain an accurately calibrated camera and camera/laser. The parameters from the camera calibration included the focal length, lens distortion coefficient, and an uncertainty scale factor due to scanning and sampling error. This method involves solving a linear set of equations, and then applying a nonlinear optimization technique to reduce the error of a perspective transformation. The parameters from the camera/laser calibration include the angle and distance of the laser plane to the optical axis. These parameters are found by certain geometric constraints of the calibration plane. By incorporating the described techniques, the camera calibration gives a mean absolute error of .5 mm (or 1/4000 of the working distance) for measurements made on the calibration plane, and the camera/laser calibration gave a mean absolute error of 5 mm (or 1/400 of the working distance) for the actual measurements of the 3D model.

DETERMINING CLOUD COVERAGES FOR INPUT TO THERMAL CONTRAST MODELING

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Abstract

The percent cloud cover greatly affects the amount of transmitted solar radiation as well as its rate of attenuation through the atmosphere. A whole sky imaging unit was used to capture one and ten minute resolution data for analysis through various image processing techniques. These processed images were then used to provide input to a thermal contrast model for predicting thermal crossovers (in the 8-12 micron range) between targets and their background environments.

MILLIMETER WAVE-INDUCED HYPOTENSION DOES NOT INVOLVE HUMORAL FACTOR(S)

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Abstract

In ketamine-anesthetized rats, sustained whole-body exposure to 35-GHz millimeter wave radiofrequency radiation (RFR) produces hyperthermia, visceral vasodilation, and subsequent hypotension resulting in death of the subject (Physiologist 34:246, 1991). This study sought to determine whether this phenomenon (i.e., eradication of compensatory splanchnic vasoconstriction precipitating hypotension) is caused by vasodilatory factor(s) present in the circulating blood during circulatory failure. In search of evidence for a humoral visceral vasodilator, we performed a blood transfusion experiment. Two groups of rats (n=10 for each group) were used for the protocol. In the experimental group, one rat (donor rat) was exposed to RFR until mean arterial pressure (MAP) fell to 75 mmHg (arbitrarily assigned point of shock induction from previous work). At this point, 5 ml of blood were withdrawn from the hypotensive rat via the left carotid artery. This blood was subsequently infused into the recipient rat via the right jugular vein while an equal volume of blood was withdrawn simultaneously from the right femoral artery. MAP was monitored on the recipient rat for a 5 minute control period prior to transfusion and during the entire transfusion. In the control group, the same procedure was employed without exposing the donor subject to RFR. Therefore, in the control paradigm, the donor subject was normotensive when the blood was withdrawn. Immediately following transfusion in both groups, we observed an initial decrease in MAP followed by a similar increase returning MAP to control period levels. The recipient rats in the experimental paradigm did demonstrate a more pronounced decline in MAP post-transfusion as compared to the recipient rats in the control group (20.4 mmHg to 9.3 mmHg, respectively); however, those differences in mean maximum decrease in MAP were not shown to be significant ($p=0.051$). Therefore, we conclude that the vasodilatory factor(s) is not a humoral agent.

USING ELECTRONIC BRAINSTORMING TOOLS TO VISUALLY REPRESENT THE IDEAS OF OTHERS: A PROPOSAL FOR RESEARCH

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and

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The manner in which electronic brainstorming tools visually represent ideas may have important consequences for ideational performance. Existing information displays differ with respect to (a) the degree to which users control their own access to group information, (b) the visual representation of the information on the screen, and (c) the emphasis on group versus individual productivity. An explanation for the apparent lack of creativity of electronically assisted, interacting groups is presented based on the distinction between blind versus heuristical search processes. It is argued that, while existing brainstorming tools eliminate or reduce the detrimental effects of various situational factors, the cognitive algorithm typically used by brainstormers in interacting groups, the trailblazing heuristic, still prohibits the exploration of previously activated ideational categories. Three computer brainstorming studies, involving manipulations of motivational orientation and information display, are proposed in order to explore the effects of this heuristic search process on ideational performance. The results are expected to enhance the development of effective brainstorming software.

Preliminary Characterization and Calibration of Micro Shear Stress Sensors in a Compressible Flow.

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Abstract

The feasibility of using a Caltech/UCLA designed micro shear stress sensor in a compressible flow environment has been proved. Uniformly and non-uniformly doped micro sensors (designed using MEMS technology) were tested in the Mach 3 High Reynolds Number Facility at Wright Laboratories. Using a polynomial fit-extrapolation (of previous data) for the skin friction coefficient within the tunnel, the sensor voltage output versus wall shear stress compared well with empirical calibration models derived from hot film sensor operating in incompressible flows. The frequency spectrum of the data obtained from the micro sensors displayed the characteristic 5/3 power slope associated with the inertial subrange. Some frequency regions in the power spectrum of the results were identified, after applying frequency compensation methods, as having potential for future investigation, as well as future research and applications are outlined.

HIGH SPEED IMAGING INFRARED POLARIMETRY

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ABSTRACT

High Speed Imaging Infrared Polarimetry is a technique which enables the Stokes Vector of a scene to be determined on a pixel by pixel basis. This technique can be used to measure the circular component of the Stokes vector using a Photoelastic Modulator and a Linear Polarizer. When a Quarter Wave Linear Retarder is added the technique is capable of measuring the linear components of the Stokes Vector. The Photoelastic Modulator oscillates at a rate of 37 kHz. Measurements of this oscillating signal can be used to determine the Stokes Vector of the detected light. A 3 x 3 array of HgCdTe detectors are used to aid in the imaging process. The DC detected signal is amplified with nine custom circuit boards developed at University of Alabama in Huntsville. The data is acquired and analyzed with custom computer software on a 486/33 PC using 5 dual channel GageScope oscilloscope boards. The calibration consists of determining a Polarization Measurement Matrix which is then used to determine the incident Stokes Vector from the time varying detected signal. This matrix should be determined for the system operating in both the circular and linear mode. Measurements taken of blackbody radiation sources of simple geometries can be used to verify the technique.

TRANSFERRING TECHNOLOGY VIA THE INTERNET

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Abstract

The current global economic climate is such that a nation acquires and maintains its wealth, prosperity, and strength predominantly through trade. It is necessary, but no longer sufficient, for a nation to possess a strong military function in a global marketplace. This new emphasis on national competitiveness in trade places Rome Laboratory, as well as other federal laboratories, at an important crossroads. On the one hand, a military advantage requires continual technological superiority. On the other hand, Rome Laboratory needs to facilitate national economic development through the transfer of its technologies into the marketplace. These developments serve to highlight the importance of a proactive technology transfer process within Rome Laboratory. However, a proactive operation is difficult to put into action without forthcoming budgetary and personpower increases. This study focuses on a low-cost alternative: to use MOSAIC on the Internet and the World Wide Web to promote the transfer and commercialization of technology. An electronic system was developed allowing access on various technology transfer information and databases to the private sector, as well as Rome Laboratory and other Air Force and public sector users. This report describes these efforts, underlying reconceptualizations, design and implications of the electronic system.

FABRICATION AND WHITE-LIGHT CHARACTERIZATION OF ANNEALED PROTON EXCHANGED CHANNEL WAVEGUIDES IN LITHIUM TANTALATE

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Abstract

The conditions for the fabrication of single mode channel waveguides in lithium tantalate at 1.31μm are given, followed by a characterization of the guides using a white light source in order to accurately define the regions of cutoff and modal operation. Channel waveguides were implanted in a z-cut lithium tantalate substrate by the Annealed Proton Exchange technique. Single mode operation at 1.31μm was verified for guides of mask widths 3.5μm to 8μm by exciting them from a laser source and focusing the output onto an IR camera. Waveguides of widths 2μm to 10μm were then excited from a white light source and their output power measured as a function of wavelength from 870nm to 1700nm. From these plots, a single graph was constructed giving the value of cutoff wavelength versus channel mask width for the fundamental through fourth order modes. Near-field profile measurements were also made on various guides at 0.890μm and 1.31μm.

PREDICTION OF THE PERFORMANCE OF A 7-STAGE AXIAL-FLOW COMPRESSOR WITH WATER INGESTION USING A SINGLE-PHASE MODEL

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Abstract

A single-phase analytical model has been developed to predict the performance of an axial-flow compressor with liquid water ingestion. Performance of a generic 7-stage axial compressor operating at three corrected rotation speeds, three corrected mass flow rates, and five mixture compositions was predicted using the model. The effects of liquid water ingestion upon power absorption, total pressure, static pressure, total temperature, and static temperature were predicted. The direction of the performance trends predicted by the model were found to agree with the direction of the performance trends obtained by S.N.B. Murthy; however, the magnitudes of the predicted performance trends could not be directly compared with Murthy's predicted performance trends due to differences in model output parameters between this model and Murthy's model. [2] This model predicts much higher evaporation rates than Murthy's model. Murthy's model predicts little evaporation of water, while this model predicts complete evaporation of water for the same mass fractions of liquid water.

Scanning Image Algebra Networks for Vehicle Identification

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ABSTRACT

Digital image analysis techniques for identifying vehicles in complex scenes were studied. Neural networks that learn image algebra operations for feature extraction and classification simultaneously were applied to the problems of detecting tanks in Infrared (IR) imagery and Chevrolet Blazers in visible imagery. Results on the tanks reconfirmed earlier results with different networks that show networks are capable of generalizing from a much smaller set of examples than matched filters. The Blazers were in parking lots filled with a variety of vehicles. Several test Blazers were in the lot at a variety of ranges, aspects, and depression angles. Empirical results show that the image algebra networks can store a variety of representations of Blazers, including range, aspect and plane rotation angles. In addition, the networks exhibited the capability of generalizing to Blazers with different paint and options in some cases and could detect partially occluded Blazers. Further research is required to suppress network output on complex backgrounds.

A MODEL BASED REAL TIME IMAGE PROCESSING SYSTEM

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Abstract

This report presents the results of the 1994 AFOSR–RDL Summer Research Program. A system was developed which uses model based techniques to create real time data parallel implementations of image processing algorithms. The system, called PCT (Pipeline Cut Through) achieves real time execution by automatically parallelizing the algorithms and scaling the solution to the level of parallelism needed to reach the target data rate. The PCT system has been shown to be fully programmable and scalable, two features provided by the modeling concept. The hardware platform of the PCT system is an interconnected network of TI TMS320C40 DSPs. The current prototype is capable of performing an arbitrary length pipeline of user defined computations on 512x480, $8\frac{bit}{pixel}$ frames at the target rate of 30 frames per second[1], given that enough C40s are available in the hardware architecture. While performing an edge detection application, a large system containing 41 C40s was been benchmarked at 440Mflops sustained (counting only useful computations). However, smaller systems (on the order of 6 processors) have also been shown to be efficient and useful for applications such as screech detection. Due to the use of model based techniques, the system can be scaled up or down by simply removing or adding C40s to the hardware architecture, and the software application can be reconfigured by merely changing the models. PCT has been tested extensively, and is expected to be used in a turbine engine test later this year.

[1] The digitization resolution (width and height of the digitized frames), the data depth (bits per pixel), and the frame rate are adjustable. However, $512x480x30 = 7.3\frac{Mbytes}{sec}$ is the highest data rate yet achieved due merely to the limitations of the C40 communication link. Future plans include increasing this maximum data rate by a factor of nearly 5, to at least $35\frac{Mbytes}{sec}$ by using multiple data paths.

LABORATORY EXPERIMENTS WITH THE VERSATILE TOROIDAL FACILITY(VTF) TO INVESTIGATE IONOSPHERIC PLASMA TURBULENCE

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Abstract

Laboratory experiments with the Versatile Toroidal Facility (VTF) have been conducted to investigate plasma turbulence and effects on electromagnetic waves. These experiments are aimed at simulating the ionospheric plasma environment and cross-checking our ionospheric heating experiments at Arecibo, Puerto Rico. Reported here is some of the research Daniel T. Moriarty has conducted over the past five and half years under the supervision of Prof. Min-Chang Lee since his junior year at M.I.T. Dan Moriarty participated in the construction of VTF, which can generate magnetized plasmas with sharp density gradients and intense magnetic field-aligned currents. The VTF Plasmas thus have the key characteristics of the ionospheric plasmas, especially in the auroral region. The VTF plasma turbulence is structured with low-frequency wave modes which can be similarly produced by the sharp plasma density gradients and/or field-aligned currents in the ionospheric F region and in the topside ionosphere. The results of the VTF laboratory experiments are compared with those of the rocket experiments in space. We show that VTF can adequately simulate the naturally occurring plasma turbulence in the auroral ionosphere and complement the active plasma experiments in space.

RAPID BACTERIAL DNA FINGERPRINTING BY THE POLYMERASE CHAIN REACTION

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Abstract

Typing of bacterial strains by polymerase chain reaction fingerprinting was studied. Bacterial strains were grown overnight and the DNA isolated by the CTAB method. This study utilized REP and ERIC primers, which target dispersed repetitive sequences, for gram negative bacteria (especially *E. coli*, *Salmonella*, and *Pseudomonas*). Primers were derived from repetitive sequences in *M. pneumoniae* and used with the gram positive organism *S. aureus*. Differential fingerprints were obtained by PCR showing which strains were derived from the same bacterial clone.

PROPOSAL FOR THE ESTABLISHMENT OF A COMPREHENSIVE MOTION PERFORMANCE TEST SYSTEM FOR INCLUSION IN ADVANCED SPATIAL DISORIENTATION DEMONSTRATOR MAINTENANCE TESTS AND RESEARCH ACTIVITIES

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Abstract

A proposal for the development of a comprehensive Motion Performance Test System (MPTS) to be included in future Advanced Spatial Disorientation Demonstrator (ASDD) maintenance tests and research activities is presented. The basic layout and operation of the ASDD is discussed briefly in the introduction to give the reader a proper perspective on the system as a whole. A major limitation of the ASDD is then highlighted; due to the proprietary nature of the ASDD's hardware and software components, there is no current availability of a computer system that makes provisions for acquiring and storing relevant motion performance data or physiological data, which will be important for future maintenance, training, and research activities. It is then argued that a separate MPTS should be designed and installed within the ASDD to perform data acquisition and analysis, thus providing users of the system with the much needed ability to measure and track the actual orientational and dynamic performance characteristics of the ASDD. It is also shown that those involved in ASDD training and research criteria would benefit from such a system. Finally, the hardware and software components of the MPTS are presented, along with a description of how these components would be utilized to acquire and store the necessary performance data. The central theme of this proposal is clearly emphasized: the capability of acquiring and storing relevant performance and physiological data for later analysis will be crucial to future maintenance, testing, training, and research criteria involving the ASDD.

AUTOMATIC CONTROL ISSUES IN THE DEVELOPMENT OF AN ARTIFICIAL PANCREAS

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Abstract

Recent developments in technology for the treatment of diabetes mellitus enable sensing and control of key chemical/hormone species related to the disease. Further, it is expected that non-invasive (infrared) blood glucose sensing techniques will permit continuous on-line sensing of blood glucose levels in insulin-dependent diabetics. It is thus desired to apply modern control systems design techniques in the design of an artificial pancreas in order to provide a robust, fault-tolerant design suitable for clinical and at-home use. A preliminary effort toward this goal was undertaken during the 1994 Summer Faculty/Graduate Student Research program at Eglin Air Force Base; a complementary study is presented by Dr. A. S. Hodel in Summer Research Program Report 29. The effort presented in this report comprises the development of (1) strong background necessary for understanding the dynamics of glucose metabolism (2) a qualitative model of endocrine kinematics related to glucose management and (3) control applications to the glucose regulation models developed.

SYNCHRONIZATION USING CONTROL: CHAOTIC DIODE RESONATORS

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Abstract

Investigations of the synchronization of chaos by control process [Y.C. Lai and C. Grebogi Phys. Rev. E **47** 2357 (1993).] as applied to diode resonators are presented. It is shown that required synchronizing factors may be obtained from a time series of the resonator. Calculations made of the global and local Lypaunov multipliers of the dynamical system show that synchronizing perturbations force these multipliers to be less than one. When the global Lyapunov multiplier is forced less than one, synchronization of chaos will occur.

RELAXATION PROCESSES IN GAIN SWITCHED IODINE LASERS

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Abstract

The dynamics of a gain switched, low pressure photolytic iodine laser were investigated experimentally and theoretically. The pulse shape, build-up and decay time were measured as function of the pressure of the active medium (CF_3I) and of the pressure of the buffer gas. At low pressure, the pulse develops a second peak, and the build-up and decay times become longer. The distinct features of the iodine pulse could be explained in terms of two relaxation processes involving collisions that change the direction and magnitude of the velocity vector. A computer model based on the rate equations which includes collisional relaxations allowed us to derive quantitative estimates for the corresponding relaxation times as a function of pressure and buffer gas.

A STUDY OF RF FIBER OPTIC COMMUNICATION LINK TECHNOLOGY

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Abstract

In this paper the design, application and performance of RF fiber optic communication links (FO links) are considered for integration in the Pave Pace avionics architecture. Included is a comprehensive definition of relevant terminology, the reasoning behind present device selection, characterization, performance, and suggestions for future development. Particular attention is given to achieving the minimum detectable signal (MDS) and dynamic range required for RF avionics application. Various network configurations and optimization techniques are discussed, including: central versus remote data mixing, dedicated FO links, analog wavelength division multiplexed (WDM) FO links, and digital time division multiplexed (TDM) FO links. It is proposed that a composite FO network combining remote data mixing and external optical fiber modulation techniques will be most likely to achieve the MDS and dynamic range requirements.

Integration Of Optoelectronic Devices With Microwave Compatible Diamond Heat Sinks

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Abstract

Thermal stability of an optoelectronic device, a vertical cavity surface emitting laser, is addressed by flip-chip mounting it onto a chemical vapor deposited diamond heat sink. This project used previously designed heat sink patterns to investigate their actual fabrication. Heat sinks fabricated in this study and previously fabricated lasers were then used to experimentally determine the procedure for flip-chip mounting the devices. The result of the study is a series of techniques for fabricating heat sinks and a reliable and repeatable process for flip-chip bonding the laser die onto the heat sink using indium solder.

AN INVESTIGATION OF FLIGHT CHARACTERISTICS OF THE ROCKET ELECTRIC FIELD SOUNDING VEHICLE

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Abstract

The Rocket Electric Field Sounding (REFS) rocket is part of a program at Phillips Laboratory which examines electric fields present in thunderstorms. Numerous flights of this rocket have occurred, and some peculiarities have arisen. The rockets did not achieve the predicted apogee values, and the roll characteristics of the rocket show a region where the spinup is either stopped or significantly impeded. The work carried out this summer focused on the potential for higher drag occurring during flight to account for the lower altitudes as well as an investigation of the fin aerodynamics with respect to the rolling motion of the rocket. The preliminary results of the research show that the roll plateaus can be explained due to high induced fin angles of attack in the thrusting phase, and that a combination of higher than expected drag and lower than expected thrust probably caused the lower apogee of the rocket.

A NUMERICAL STUDY OF DROPLET-VORTEX INTERACTIONS IN AN EVAPORATING SPRAY

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Abstract

In this paper, we present the time-dependent axisymmetric numerical simulation of an unsteady n-heptane evaporating spray, and investigate the droplet-vortex interactions which determine the structural and dynamic characteristics of a spray jet flow. The spray is formed between a droplet-laden heated nitrogen jet and a coflowing air stream. A detailed, multidimensional, two-phase algorithm is developed for the simulation. A comprehensive vaporization model is employed to calculate the instantaneous droplet size and surface temperature along the trajectory of each droplet group. Monodisperse spray in introduced into the large vortex structures that are generated due to the presence of buoyancy-induced hydrodynamic instability of the heated jet. Results focused on the two-way interactions between vortical structures and droplets, and the dynamics of both non-evaporating and evaporating sprays. The vortex structures cause droplets to disperse radially outward, and this in turn determines the fuel vapor distribution and also modifies the vortex dynamics. Thus, the dynamics and structural characteristics of the evaporating spray are strongly influenced by the two-way transient interactions. The effects of initial droplet size, injection location, and liquid-to-gas mass loading ratio on these interactions are also investigated.

THERMOLUMINESCENCE OF SIMPLE SPECIES IN SOLID MOLECULAR HYDROGEN MATRICES

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Abstract

In an attempt to develop chemical propellants which would exceed the performance of the current state of the art liquid oxygen/liquid hydrogen system, we are revisiting the concept of using atomic and molecular radicals as high energy additives to cryogenic sold molecular hydrogen (SMH) fuels. This report details our efforts to produce and characterize samples of prototypical SMH fuels which will yield visible thermoluminescence (TL) from radical recombination upon warm up. This TL property will be used as a diagnostic of fuel stability in subsequent storage and handling experiments. The simple gases: N_2, O_2, CO, CO_2, and CH_4, as well as various mixtures of N_2 with the others, passed through a microwave discharge and were co-deposited with gaseous D_2 at 3 K. The TL emission spectra, and total TL intensity were recorded during warm up of these samples. Most TL emission from the D_2 matrices occurred between 4 and 8 K. N_2 was the only gas which yielded TL by itself, while O_2 and CO were the only gases to yield new TL emissions in N_2 mixtures. N_2 was also discharged and deposited without D_2 gas, and TL was observed from these samples. The transitions evident in the TL emission spectra have been assigned and a kinetic scheme has been proposed for nitrogen TL due to recombining N atoms. The strongest feature in these spectra was assigned to the Vegard-Kaplan bands $A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$ of molecular nitrogen. Along with an N atom emission due to the $2p^3$ (^2D) $\rightarrow$ $2p^3$ (^4S) transition, a peak assigned to the $2p^4$ (^1S) $\rightarrow$ $2p^4$ (^1D) transition of the O atom was also observed (due to an air impurity). The analysis of the total TL intensity data includes a first attempt at fitting to a first-order kinetic model, which unfortunately yielded unphysical values for the N atom detrapping frequency factors and activation energies.

A PARAMETRIC STUDY OF THE FACTORS AFFECTING THE OPEN AND FILLED HOLE PERFORMANCE OF FIBER REINFORCED COMPOSITE MATERIALS

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Abstract

The effect of fiber stiffness, matrix toughness and fiber orientation on the open and filled, drilled hole tension and compression performance and drilled hole bearing performance of continuous fiber, polymer matrix composites was investigated. Failure characteristics of tested specimens were studied using fractographic techniques. Fiber type and lay-up were found to have the biggest effect on the tensile data while test type (open hole versus filled hole) had little effect on the data. Test type and lay-up were the parameters having the largest effect for the compressive data. Hole size most significantly affected the bearing data. Results of an extended isotropic analysis showed that the stress concentration factor for materials 1 (AS-4/3501-6) and 2 (IM-8/3501-6) was greater for stacking sequences 3 ($[60/0_2/-60]_{2}]_{2s}$) and 4 ($[60/-60/0_2]_{2s}$) than for stacking sequences 1 ($[45/90/-45/0]_{2s}$) and 2 ($[45/-45/0/90]_{2s}$). This result was consistent with the data obtained through testing. Fractographic examination of tested specimens showed that test type, stacking sequence, fiber type or matrix type had little effect on the failure characteristics for the open and filled hole tension specimens but test type, matrix type and stacking sequence had some effect on failure characteristics of the open and filled hole compression specimens. All of the bearing specimens failed in a bearing type mode. For both materials the damage appeared to be slightly more significant for the 0.125 inch diameter hole bearing specimens than for the 0.250 inch diameter hole bearing specimens. The failures appeared to be independent of lay-up or fiber type but somewhat dependent on matrix type.

S-PARAMETER MEASUREMENTS ON A GaAsFET VARIABLE-GAIN AMPLIFIER

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and

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Abstract

A project was done to study the performance of a two-stage GaAsFET variable gain amplifier. We performed tests on several samples of this device, and each sample was tested in 128 different states of variable gain. We made S-parameter measurements over the frequency range of 4.0 - 9.0 GHz for each of the 128 states and compared these measurements against published performance specifications for the device. We went to great lengths to perfect the grounding scheme of our experimental setup so that we could achieve results that accorded with the published specifications.

MULTISENSOR-MULTITARGET DATA FUSION USING AN S-DIMENSIONAL SLIDING WINDOW ASSIGNMENT ALGORITHM

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Abstract

The tracking process as generally practiced today consists of the interrelated functions of association and estimation. Association is the decision process of linking observations (measurements) of a common origin (target). A set of linked observations can then be statistically filtered to estimate the states of targets. The central problem in the multisensor-multitarget data fusion process is that of data association, that is, the problem of determining from which target, if any, a particular measurement originated. Measurements originating from a particular target can then be fused to estimate the states of targets not directly measured by sensors. Furthermore, in dense multisensor-multitarget scenarios, data association is the most computationally expensive aspect of tracking. Mathematically, the data association problem for tracking can be formulated as a multidimensional assignment problem, for which is NP-hard, and therefore intractable when the degree of dimensionality is greater than 2. However, the S-dimensional assignment algorithm (*S* refers to the number of dimensions) developed by Pattipatti [9,10] and Deb [4-6], is a suboptimal Lagrangian relaxation-based technique that is an efficient and polynomial-time solution to the generalized multidimensional assignment problem.

To exacerbate the problem, when the degree of data association is across too few scans, misassociations are more probable and thus become more problematic. As a result, these misassociations inevitably will lead to poor track performance, loss of track, inaccurate estimated target position, and tracking errors far worse in reality than those predicted by the estimation scheme. However, because of the lack of any a priori estimates of target states, reliable track initiation may improve if the data associations are optimized over multiple scans. Moreover, in track extension, misassociations can be reduced significantly if the data association is optimized over multiple scans [4]; any misassociations in earlier scans will result in a subsequent degradation in solution quality; hence, optimizing the solution of S scans will significantly reduce the chance of misassociation. The near-optimal S-dimensional assignment algorithm described in [4-6] is highly efficient, recursive, and ideally suited for a multiscan sliding-window implementation.

The purpose of this paper is to demonstrate the use of the "sliding" multiscan windows approach in solving the multidimensional assignment problem for both track initiation and track extension. As part of AFOSR funded research and the current research effort for Rome Laboratory, the University of Connecticut has developed several data association and estimation algorithms for actual tracking problems of interest to the Air Force. One such algorithm developed by Pattipatti [9,10] and Deb [4-6] is the near-optimal, highly recursive, polynomial time S-dimensional assignment algorithm. In this work, as part of AFOSR's Summer Research Program, we implemented and tested (via an actual non-stressing multisensor-multitarget data set) a multiscan sliding-windows tracker utilizing the S-dimensional assignment algorithm as our data association component. The overriding objective was to demonstrate the use of a (sliding) multiscan window approach in addressing the problem of efficient and reliable data association, over time, for track initiation and extension.

ANALYSIS AND COMPARISON OF THE PERFORMANCE/LIFE COMBUSTION AND THE ROCKET COMBUSTION INTERACTIVE DESIGN COMPUTER MODELS

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Abstract

The Performance/Life Combustion (PLC) and the Rocket Combustion Interactive Design (ROCCID) computer models were analyzed and compared. The purpose of the present research was to determine which model was better suited for modification to better describe the fluid mechanics that influence combustion chamber performance. Although ROCCID incorporates more physical processes into its model than PLC, its highly simplified combustion chamber performance calculations are primarily used to evaluate the stability of the combustion chamber while PLC is applicable to multiple injector configurations. Therefore, PLC was selected for refinement. The result will be a model that simultaneously evaluates the conservation equations and allows the area of each grid cell to change, with the constraint that pressure is constant at any axial location.

DEVELOPING AN AUTOMATIC VOICE AND IMAGE COMPUTER LOGIN PROCEDURE

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Abstract

An automatic computer login procedure that uses voice identification and picture verification was developed. This procedure is a departure from the standard typed user name and password entry system. By training a unique voice pattern and verifying with images, computer login security should improve. The voice identification and training can use a commercially available voice system such as Bolt, Beranek and Newman's (BB&N) HARK 2.0 . Time limitations prevented the complete development of the system and this report mainly consists of the attempts to develop the image verification portion. Preliminary results were lukewarm but there are several recommendations that should improve performance.

Local Area ATM Network Interfaces

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Abstract

In this paper we discuss the programming interface available to the ATM application programmer, as provided by the SBA-100 ATM network adapter and ASX-100 ATM local network switching system from FORE Systems. A comparison is made between the throughput achievable using the BSD socket interface to ATM and the traditional Ethernet. The application programming interface (API) provided by FORE is also described, along with relevant information on the FORE System products, noticed while experimenting with the local ATM test network.

MODIFICATIONS TO THE THINKER DISCOVERY SYSTEM

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Abstract

A discovery system is a computer program which utilizes a little knowledge and vast amounts of data to discover rules and relationships which exist in the data. The discovery system Thinker is comprised of algorithms, graphical displays, control procedures, and a knowledge base. The work this summer focused on improving the capabilities of the discovery system Thinker by modifying a regression algorithm, the consulting session, and redesigning the knowledge base - giving the discovery system greater flexibility.

THE DYNAMIC CONVECTION REVERSAL BOUNDARY

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Abstract

Convection reversal boundaries which occur near the border of the northern summer polar cap ionosphere were observed by the radar at Sondre Stromfjord, Greenland, DMSP F9, F10 and F11 satellites, and the Greenland and MAGIC chains of magnetometers. The reversals observed were categorized into three different classes, Stationary and Uniform, Nonstationary, and Oscillating. A stationary and uniform boundary remains at the same invariant latitude for long periods of time and demonstrates no observable motion. A nonstationary boundary remains parallel to a line of invariant latitude, but will propagate northward or southward. The oscillating boundary will have wave-like motions on the reversal. A number of different boundaries were classified and then further studied to determine the causes for the different types of reversals. The flow across the reversal was also analyzed and found to be greater than the tangential flows in some cases and weak to nonexistent in other cases.

A STUDY OF INTERACTION IN DISTANCE LEARNING

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Abstract

Interaction in distance learning was studied. A survey of the literature found that most studies were lacking in rigor and the methodologies were weak in regards to interaction. To answer the many questions about interaction effects in distance learning, a better definition of the variable interaction is needed. This paper lays out a taxonomy of interaction for evaluation and research.

GENDER AND RACIAL EQUITY OF THE AIR FORCE OFFICER QUALIFYING TEST (AFOQT) IN OFFICER TRAINING SCHOOL SELECTION DECISIONS

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Abstract

The present study investigated the relationship between performance on the Air Force Officer Qualifying Test (AFOQT) and performance in Officer Training School (OTS) for race and gender. All composites were shown to be valid predictors of OTS performance for all subgroups. Minority subgroups had lower mean scores on the aptitude composites. Regressions of Final Course Grade and Officer Training Effectiveness Reports (OTER) on aptitude composites were compared for gender and racial subgroups to assess the predictive equity of three AFOQT composite scores (Academic Aptitude, Verbal, and Quantitative) for OTS. Results were consistent with the literature in education, industry, and prior studies conducted in the military. Predominant findings showed evidence of level bias in the prediction of Final Course Grades for both gender and racial subgroups. However, in all cases of level bias, minority subgroup performance was overpredicted, resulting in a higher selection rate for female and black cadets into OTS. Implications of the results and suggestions for future research are discussed.

IMPROVED NUMERICAL MODELING OF GROUNDWATER FLOW AND TRANSPORT AT THE MADE-2 SITE

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Abstract

Public domain computer programs were used to attempt an improved model of the tritium plume observed during Macrodispersion Experiment 2 (MADE-2), a field scale natural gradient experiment conducted at Columbus Air Force Base, Mississippi. The program Geo-EAS used head and hydraulic conductivity data at a relatively small number of irregularly spaced test locations to estimate corresponding values at the more numerous nodes of a computational grid having 66 rows, 21 columns, and 9 layers. The finite difference program MODFLOW was used to simulate the flow of groundwater through a 330 m x 105 m computational domain. The recent BCF2 subroutine package, which permits rewetting of cells, allowed the vertical discretization to be more accurate than in previous studies. Solutions for the 468 day experiment were obtained using a Sun Sparcstation 2 for several choices of convergence and storage parameters. The simulations had small mass balance errors and were consistent with continuous head observations. The smallest storage coefficients gave the best agreement. One persistent feature of the predicted head field was a tendency for the head to decline toward the northwest. This suggests that the plume should bend toward the northwest, but the observations show a bend toward the northeast. This discrepancy is probably due to inaccurate head boundary conditions resulting from a lack of piezometers in the northern part of the computational domain. The flow model is about as accurate as the data permit.

Tritium plume simulations used the mixed Lagrangian-Eulerian finite difference program MT3D to solve the contaminant transport equation using the MODFLOW-predicted flow field. Thirteen runs were made using various advection algorithms and dispersivities, but none was successful. Numerical instabilities or grossly unrealistic predictions ended every run by simulation day 141. Further work is needed to obtain a satisfactory plume prediction.

THE WORKLOAD ASSESSMENT MONITOR: PROGRESS TOWARDS ON-LINE CLASSIFICATION OF MENTAL WORKLOAD IN HUMAN SUBJECTS

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Abstract

The primary goals of the current project were to test the WAM system in a multi-task environment which represented three different MWL conditions, determine which EEG sites were sensitive to the different multi-task scenarios, and to refine the EEG bands to be used as input to the classifier. Based on visual inspection of the performance results it was determined that three levels of MWL had been established using the MATB software. Clearly, the WAM classifier was not sensitive to differences in MWL as the average classification score for each MATB task scenario was approximately 2. The EEG spectral bands used as input features to the WAM classifier in the present study where not the same as suggested by the PCA analysis. The PCA analysis indicates that the Alpha band should be used as an input feature but does not provide support that the Theta band helps discriminated MWL. Instead the results of the PCA indicated that in addition to the Alpha band, a high frequency band may prove to be a better input feature to the WAM classifier than the Theta band as indicated by the significant factor scores in the high frequency region. Analysis of the MATB data indicates the workload classes are not separable using the current feature inputs. These results suggest that the means for all three MATB scenarios may have been very close and the covariances were large resulting in a large degree of overlap using the current frequency domain input features (i.e., Alpha and Theta bands).

SELF-SUSTAINED PULSATION AND
HIGH SPEED OPTICAL NETWORK NODE

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ABSTRACT

During my research period at Rome Labs I had worked on three projects simultaneously. One of the projects studied Self-Sustained Pulsation(SSP) from laser diodes. SSP was studied as a means of creating an inexpensive high bandwith optical communication system. The other two projects were related high speed optical networks. Two components of the electrical control system were evaluated and modified to operate in a network running at 2.5 GHz bit rate.

Self-Sustained Pulsation(SSP) is an intrinsic intensity modulation occurring in laser diodes when biased above the required lasing threshold current. SSP is generally considered undesirable in continuos-wave(CW) laser diodes. The phenomenon was found at several investigated wavelengths. SSP can be used as a carrier wave for high bandwidth modulated information transfer. During the work at Rome Labs a microwave feedback system was installed to enhance the SSP. The SSP carrier was then used to successfully transmit and receive AM and FM test signals.

Previously demonstrated at Rome Labs was a two port network node which passed optical data without the need for regeneration. This system operated at a 1.2 GHz transmission speed and will soon be operating at 2.5 GHz. Several of the circuits were in need of optimization so as to perform satisfactorily at the 2.5 GHz bit rate. Three electro-optic switch drivers were in need of such a review. These analog circuits received a small input signal (0 $\rightarrow$ 1 Volt) and were required to switch the output from 1 $\rightarrow$ 9 Volts in approximately 10 mseconds. The original circuit proved to be sufficient for this task. The only changes required were in the board layout and a minor change in rated power supplies.

The AC coupler, also to be part of the 2.5 GHz optical communications node, was needed to provide drive current and isolation. The original AC coupler circuit provided isolation from a kilohertz range through 100 MHz. The completed circuit successfully coupled data with reasonable accuracy within the range of 50 MHz through 3 GHz bit rates. At the target speed of 2.5 Ghz the device demonstrated an acceptable eye-diagram.

PICLL: A PORTABLE PARALLEL 3D PIC CODE IMPLEMENTATION NOTES

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Abstract

PICLL (Particle In Cell Linked List) is a three dimensional relativistic PIC code for the investigation of non-collisional plasmas and new PIC methodologies. PICLL is implemented in portable ANSI C, and has been ported to a variety of serial and parallel high performance computing systems. The overall goal of the PICLL development effort has been the production of an efficient parallel code, which is easy to use and maintain. One of the novel features of PICLL is its use of linked lists as the code's primary data structures. This report details the overall structure of the code, and some of the considerations that have gone into the early development of PICLL.

FABRICATION AND MECHANICAL TESTING OF MIXED-MATRIX CARBON-CARBON COMPOSITES

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Abstract

The high specific strength, stiffness, and thermal conductivity and low coefficient of thermal expansion of carbon-carbon composite makes it an ideal material for a passive spacecraft radiator. In support of the Carbon-Carbon Spacecraft Radiator Project at the Phillips Laboratory, a study was conducted to determine the potential to improve the specific mechanical properties of carbon-carbon composite by a final infiltration of toughened polycyanate resin. At the expense of the material's high temperature capability, filling the carbon matrix microcracks with resin promises to improve the mechanical properties of the composite without severely degrading its thermal properties. Samples were prepared with four different matrix structures: undensified carbon-carbon; undensified carbon-carbon impregnated with toughened polycyanate resin; pitch densified carbon-carbon; and pitch densified carbon-carbon impregnated with toughened polycyanate resin. Three types of mechanical tests were performed on each of these samples: longitudinal tension; interlaminar tension; and flexure. The results indicate that the mechanical properties of carbon-carbon composite can be improved by up to 61.9% with this final resin infiltration.

A STUDY OF DELAMINATION DAMAGE AND ENERGY EXCHANGE OF COMPOSITE PANELS IMPACTED AT LOW VELOCITY

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Abstract

The of mismatch angle on the damage morphology and energy that occurs during low velocity (below V50) impact of continuous fiber epoxy matrix laminated composite plates was studied experimentally. Composite plates in which the featured a different but uniform value of the change of fiber direction angle (mismatch angle) between adjacent plies on the same plate were impacted over a range of velocities from 100 to 300 feet per second, below their perforation threshold by rigid steel sphere projectiles of one-half inch diameter. The layup of 32 ply thick AS 3501 graphite epoxy plates involved constant mismatch angles between plies on each plate with the plies arranged in a symmetrical spiral staircase manner on each side of the midplane in order to produce a balanced layup. The mismatch angles employed had the value: 90, 45, 22.5, and 11.25 degree.

Projectile velocities approaching and bounce back from the plate were measured to enable the quantitation of the energy transferred to the target plates. Measurement of the change in weight of the plates provided an independent on the mass of spall generated at each velocity.

A Study of Numerical Methods in Atmospheric Light Propagation

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Abstract

The use of numerical methods to study the propagation of a wavefront through the atmosphere was studied. Many frames of Zernike polynomial coefficients were used to generate eighty term polynomials representing a degraded wavefront. Wavefronts were numerically propagated through a lens to obtain intensity distributions. The Strehl ratios for different magnitudes of phase aberration were computed.

ARTERIAL ELASTANCE IN THE MAXIMIZATION OF EXTERNAL WORK TRANSFER

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Abstract

The following work is an extension of the maximization of external work (EW) with respect to effective arterial elastance (eff. Ea) performed by Sunagawa et al. (9). A comparison of eff. Ea and physiological arterial elastance (Ea) is presented in order to clarify the main differences. Constrained maximization of EW with respect to Ea is then performed. This was accomplished by developing a ventricular-arterial coupling model to 1) estimate cardiovascular (CV) parameters from physiological data, 2) simulate the CV data and calculate EW, and 3) simulate CV data at various values of arterial capacitance and calculate EW in order to compare to the EW calculated in step 2. The model consists of a four element arterial model, a two element left ventricular model and a three element aortic valve model. The model provides freedom to change arterial capacitance while constraining mean arterial pressure (MAP) and cardiac output (CO) to within 2% by changing the heart rate. Results indicate that as arterial capacitance increases, EW asymptotically approaches a maximum slightly above the operating point and EW decreases as arterial capacitance decreases. It's concluded that Ea is maintained to provide near maximal EW; however, regulating arterial pressure and flow throughout a beat seem to take precedence.

A STUDY OF HIGH SPEED POLARIZATION ROTATORS FOR USE IN AN OPTICAL INTERCONNECTION NETWORK

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Abstract

The polarization rotation characteristics of ferroelectric liquid crystals (FLC) and lanthanum-modified lead zirconate titanate (PLZT) ceramic are studied for use in an optical interconnection network. A single pixel FLC device is found to have greater than 1000:1 contrast ratio with a rise time of 33 μs running at 7 kHz. A 10×10 FLC array, illuminated by IR light, has better than 100:1 contrast and 135 μs response time at 67 Hz. PLZT optical shutters have been reported to have response times of 1 μs and contrast ratios of 1500:1.

LOW-VELOCITY IMPACT OF MOISTURE-CONDITIONED LAMINATED COMPOSITES

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Abstract

Composite laminates are frequently used in aircraft structures, because they offer high strength and stiffness at a considerable weight savings over metals. The design criteria for composites are different from those for metals. For metals, fatigue and fracture are the major considerations. Design of laminated composites requires consideration of foreign object damage, voids in the material, and propagation of delaminations. Composite laminates are very susceptible to damage from low-velocity impacts. These events may occur during flight operations, such as impact of runway debris, or during maintenance, such as tool drop. The impact frequently leaves only a slight indentation on the surface, but there may be significant internal damage, including matrix cracking, delaminations, and fiber breakage. For this reason this type of damage is often referred to as barely visible impact damage (BVID).

During its lifetime an aircraft, and its composite structures, will be exposed to widely varying atmospheric conditions. All composite materials are hydrophilic and will absorb atmospheric moisture. Research is necessary to determine the effect of moisture on composite laminates. A number of composite specimens were moisture-conditioned in a humidity chamber to 0.7% (by weight) moisture content, heated to 350° F, and then impacted in the laboratory. The impact energies were chosen to conform to the Air Force specifications for damage tolerance. Indentation depth was measured for each specimen. The damaged composite specimens will be subjected to non-destructive evaluation to determine the size of the delaminated areas and then tested to find the post-impact compression strength.

X-RAY DIFFRACTION STUDY OF SILOXANE/CHOLESTEROL BASED LIQUID CRYSTALS

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Abstract

Liquid crystalline materials exhibit a state of aggregation that is intermediate between the crystalline solid and the isotropic liquid. A series of liquid crystalline compounds based upon derivatives of cholesterol were studied by X-ray diffraction and molecular modeling. Some of these materials have been processed into ordered, optically clear films which are of potential use as matrices for optical devices. The smectic and chiral nematic phases of four liquid crystalline dimers were examined by X-ray diffraction. Two low energy conformations of these compounds, extended and folded, were examined by molecular mechanics calculations. Models for the packing of each of these molecules in the liquid crystalline phase are proposed.

A STUDY OF LOW FREQUENCY WEAK TURBULENCE IN A HOLLOW CATHODE DISCHARGE PLASMA

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Abstract

Work was performed on a Hollow Cathode Discharge in the Nuclear Engineering Plasma Teaching Laboratory to characterize low frequency plasma oscillations and the drift wave turbulence associated with such oscillations for possible application to ionospheric plasma physics. Robust weak turbulence whose spectral characteristics depended reproducibly on the operating point of the discharge, most particularly on the axial magnetic field and on the plasma current, was measured in argon plasmas. The onset of this turbulence was found to occur at a critical value of axial magnetic field. The number of modes present as well as their amplitudes depended sensitively on axial magnetic field values above this critical value. The amplitude of the oscillations depended on the value of the plasma current.

Tactile Perception
in a Virtual Environment

Katherine M. Specht

Abstract

Previous tactile pattern perception research suggests that moving the fingertip relative to a fixed pattern is superior to other presentation modes, such as moving the pattern across a stationary fingertip. In the present study, several experiments were conducted to determine if performance in other presentation modes could be facilitated or degraded through manipulation of factors such as display size, repeated looks, and scan directions. Experiments 1 and 2 of the present study were designed to determine how far a field of view can be reduced before performance was degraded.

Experiment 3 of the present study allowed subjects to have repeated "looks" at the stimulus during static and passive scan presentation modes. This experiment was conducted in order to determine whether the ability to repeat the stimulus was the aspect of the haptic mode that had led to the performance levels observed by Weisenberger and Hasser (1994). Experiment 4 manipulated the scan direction during the passive scan presentation to determine whether advantages found in the haptic presentation could be attributed to the capability of scanning in any direction (right, left, up, down, and any oblique). Eight different scan directions were permitted.

Data from these experiments suggest that display size can be reduced to as few as 4-pins before performance is degraded. In addition, the ability of the subject to choose to repeat a stimulus and to scan in multiple directions actually facilitates performance in the static and passive scan presentation modes. Utilization of these strategies in the static and passive scan modes appears to aid processing of even complex patterns to a point which approximates haptic exploration.

The results of the present study suggest that future scan displays should continue to utilize horizontal scan directions to encourage optimal pattern identification performance. These data also imply that future displays can be constructed for practical applications in telerobotics and virtual reality research, particularly in the development of wearable displays.

PREDICTING PILOT TRAINING SUCCESS WITH LOGISTIC OR LINEAR REGRESSION: AN EXAMPLE WHERE IT DOESN'T MATTER AND WHY

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Abstract

Many studies of human attributes related to success in pilot training or job performance use linear statistical methods. For statistical prediction, linear models make few assumptions, have well known statistical characteristics, and are robust to violation of assumptions. Alternatives to these linear statistical models are classes of nonlinear statistics. A nonlinear analogue of linear prediction is logistic regression. Existence of a dichotomous criterion is frequently seen as sufficient and compelling reason for the use of logistic regression. Using the dichotomous criterion of passing-failing pilot training, we demonstrate that linear and logistic regression can yield corresponding results and would rank applicants virtually identically. Certain practical, psychometric, and interpretive advantages accrue to linear regression. A comparative discussion of linear and logistic regression is included.

ANALYSIS OF THE ABSORPTION AND METABOLISM OF TRICHLOROETHYLENE AND ITS METABOLITES BY THE RAT SMALL INTESTINE AND MICROFLORA

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Abstract

An isolated vascular perfused intestinal system was used to analysis the absorption and metabolism of trichloroethylene (TRI) by the small intestine of F-344 rats. The uptake of TRI was studied at doses of 50, 25, and 5 mg/kg body wt. The maximum cumulative uptake of TRI was found not to exceed 0.01% of any of the administered doses. The formation of metabolites of TRI by enzymes of intestinal mucosa was not observed. The low absorption and lack of metabolite formation may contribute to TRI's differential carcinogenic potential for different species. Additionally, the microflora of the small intestine, cecum, and large intestine were analyzed for the ability to metabolize TRI and its metabolites under aerobic and anaerobic conditions. Under anaerobic conditions the formation of large amounts of dichloroacetic acid (DCA) from spikes of trichloroacetic acid (TCA) was observed. Formation of DCA was often associated, but not limited to, gut contents obtained from the cecum. Also, trichloroethanol (TCOH) was formed from chloral hydrate (CH) under anaerobic conditions from cecum and large intestine samples. The degradation of TRI did not occur under aerobic conditions, but under anaerobic conditions the formation of low levels of DCA was observed. These findings show that the microflora can clearly metabolize TRI metabolites and suggest that the microflora should potentially be considered as a separate compartment within physiologically based pharmacokinetic models.

RADIATION EXPOSURE OF PHOTONIC DEVICES

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Abstract

A brief explanation of some of the radiation experiments done recently by the Photonics Research Group at the Phillips Lab is given. The radiation studies were performed in order to assess the radiation hardness of key photonic technologies that are aimed at space applications. Three devices that were irradiated by high energy protons and electrons are described. Some of the techniques for measuring the temperature rise in an acousto-optic crystal caused by radiation exposure are listed, and a suggestion is given regarding temperature measurement of a region too small for conventional thermal sensors.

SOLID PHASE MICROEXTRACTION AS A METHOD FOR QUANTIFYING JET FUEL CONTAMINATION IN WATER

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Abstract

Solid-phase microextraction (SPME) with capillary gas chromatography (GC) was evaluated as a method for quantifying jet fuel contamination in groundwater. Solid-phase microextracts were analyzed by gas chromatography using a split/splitless injection port, a fused silica capillary column (10m length, 0.10mm internal diam., 0.34μm HP-5 stationary phase) and a flame ionization detector (FID). Several components of jet fuels thought to be soluble in water were evaluated in depth. Water soluble fractions of benzene, toluene, ethylbenzene, and m-xylene gave linear responses and were quantifiable over the range of 10-1000 ppb. Water soluble fractions of n-butylbenzene and n-propylbenzene demonstrated potential for quantification over a larger range and were detectable at a concentration of 1 ppt. The effects of increasing the salinity of the sample solution on analyte response were investigated. Introduction of internal standards to the water soluble fraction of jet fuel was shown to be possible and necessary for quantification. The variation of response with thickness of the extracting fiber was investigated using fibers with 7, 20, and 100 μm thicknesses of polydimethylsiloxane (PDMS). The water-soluble fraction of JP-8 jet fuel was obtained by equilibrating the fuel with water. SPME combined with GC was used to analyze the resulting aqueous samples.

ANNEALED FUZZY CONTROL FOR A SELF-TUNING PIEZOELECTRIC VIBRATION ABSORBER

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Abstract

Two annealed fuzzy controllers for a self-tuning piezoelectric vibration absorber are presented. Similar to a mechanical damped vibration absorber, the piezoelectric absorber must be tuned to a particular mode of vibration. A self-tuning piezoelectric absorber must be able to find and track that mode if it varies in frequency due to changes in system parameters or in the environment. The controllers presented are experimentally demonstrated on a cantilevered beam. The experiments include an examination of the controllers' performance during an abrupt change in system parameters. Both controllers are able to find and track a particular mode faster and more accurately than fixed frequency increment controllers. Also, the annealed fuzzy controllers exhibit a dramatic decrease in oscillatory behavior after the mode is found. Once tuned, reductions of up to 18 dB are observed in the magnitude of the system/disturbance frequency response function. The absorber is shown to remove approximately 80% of the vibration energy from the system.

Effects of Temperature on Various Hematological Parameters

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ABSTRACT

Using human blood samples, we have determined the effects of temperature on the following hematological parameters: Erythrocyte Sedimentation Rate (ESR), Mean Red Cell Volumes (MCV), Mean Platelet Volumes (MPV), and the sodium/potassium ratio in the plasma of heat-treated whole blood. As described in reports from previous years, ESR data obtained over the range from about 30 °C and up to approximately 52 °C show distinct, abrupt, and frequently dramatic changes near 45 °C, and somewhat similar changes are observed at this temperature in the measured volume properties (MCV and MPV) and ion-distribution data. The temperature range from 44 ° to 46 °C is known to be a critical temperature range for all mammals and birds and is indeed the upper thermal limit for such organisms. As stressed in our earlier reports, the dramatic effects on cell physiology near 45 °C undoubtedly reflect the transition at the third vicinal water thermal transition temperature ($T_{k=3}$), which is known to affect a large number of parameters of the cell-associated water [see papers by Drost-Hansen et al.]. Some measurements of the same parameters have also been made at lower temperatures, for instance from 8 ° to 25 °C and from 20 ° to 37 °C. Some indications of anomalies at 15 ° and 30 °C have been seen (corresponding to the lower, critical thermal transition temperatures for vicinal water, $T_{k=1}$ and $T_{k=2}$), but the anomalies at these temperatures are far less pronounced than the 45 °C anomaly. To insure the best resolution practical, measurements have been made over the different temperature intervals at increments of 0.6 ° to 0.9 °C using our Temperature Gradient Incubator (TGI or "Polythermostat"), which allows for simultaneous measurements at thirty different, constant temperatures. Earlier, we have proposed that the distinct changes near 45 °C ($T_{k=3}$) may play an important role in hyperthermia treatment of malignancies. While the findings in the current study do not prove this supposition, the data are consistent with this proposal: dramatic changes appear to take place at this critical temperature in such parameters as the ESR (probably reflecting reduced red cell aggregation and/or rheological changes in the blood, likely related to vicinal hydration changes of the proteins present), and/or intracellular ion or solvent activities, and possibly changes in the stability of critical membrane-associated proteins or enzyme activities . Such changes may indeed preferentially affect the thermal stability of malignant cells compared to normal cells if the relative abundance of vicinal water in malignant cells differs from that of normal cells. The latter proposition is likely true as it is well-known that malignant cells have notably elevated water contents compared to healthy cells. The excess water of the malignant cells more closely resembles "bulk water" (solvent) than vicinal.

APPLICATION OF VORTICITY CONFINEMENT
TO A DELTA WING

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Abstract

The computation of high angle of attack flow over a 75° delta wing was studied. At high angles of attack a flow phenomena of vortex bursting occurs, which is of great engineering concern. The efficient numerical modelling of such a flow field has proven to be difficult, and new methods must be explored to measure their feasibility of calculating such flows. The 'Vorticity Confinement' method was added to an existing flow solver to evaluate its performance. For this evaluation, experimental, adaptive grid, non-confined, and confined results are compared. The results indicate an improvement with regards to preventing excessive diffusion of vorticity, but no improvement with regards to the flow solvers ability to enhance vortex bursting. Due to the relatively short period of time allocated for this study, such results are preliminary at best.

PIXEL PLANE DESIGN FOR A SIMD GRAPHIC PROCESSOR

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Abstract

This paper presents the design and layout of a high performance graphics processing unit. The operation of the unit is in parallel, which helps to give it high performance and allows it to take advantage of parallelism inherit inside of code and instructions. The system will run at 100MHz to handle the graphic processing, enhance the I/O capabilities of the frame buffer, and free up the CPU for more useful system operations.

A STUDY OF THE APPLICABILITY OF FRACTALS AND KINETIC EQUATIONS TO ELECTROMIGRATION AND THERMALLY INDUCED HILLOCK AND VOID EVOLUTION

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Abstract

The growth of hillocks and voids in metal films was studied. The applicability of a model involving fractals and kinetic equations was examined on the basis of whether there is independent justification for using scaling arguments in the model and for whether there is reason to connect the evolution of hillocks with that of voids. Hillocks and voids were found to be self-similar across about three orders of magnitude of variation in spatial scale with the same fractal dimension. Voids and hillocks were found to have the same fractal dimension whether studied using atomic force microscopy (AFM) or scanning electron microscopy (SEM). The parameters obtained from these fractal analyses demonstrate quantitative internal consistency with an earlier time dependent study of thermal annealing effects on hillock distributions. Remarkably, area-perimeter data obtained from either a long-time study of a single void or a spatial everage of a large number of different voids both yield quantitatively identical results.

THE COMBINATORICS OF FUNCTION DECOMPOSITION AND APPLICATIONS OF LEARNING THEORY

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Abstract

The use of function decomposition as a Machine Learning technique is explored combinatorially. Results from Computational Learning Theory are applied to get an upper bound on the minimum number of samples that function decomposition requires to accurately learn any function. This bound is exponential in the size of the function, but linear in the complexity of the function as measured by Decomposed Function Cardinality. In the process of exploration, two other discoveries are made. First, the greedy method of searching for a function decomposition currently in use by the Pattern Theory research team cannot find decompositions for a significant number of functions. Second, the assumption of a Solomonoff-Levin distribution on functions from the real world may not be as reasonable as it is believed to be, since it could lead to the conclusion that the real world is random.

DOCUMENTATION OF BOUNDARY LAYER CHARACTERISTICS FOR LOW CHORD-REYNOLDS-NUMBER FLOW ON THE SUCTION SURFACE OF A LOW-PRESSURE TURBINE AIRFOIL

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Abstract

It is recognized that the low-pressure turbine has, because of its low chord Reynolds number, regions of strong acceleration and diffusion effects. Consequently, there are extended regions of transition from laminar to turbulent flow and there is a strong likelihood of having regions of flow separation. To investigate this low-Reynolds number flow, a program was initiated where a representative low-pressure turbine airfoil configuration is installed in a wind tunnel facility and run at chord Reynolds numbers of 40,000 and 80,000. High background turbulence and disturbances from passing wakes are imposed upon the flow to simulate the turbine environment. The boundary layer state, laminar-like or turbulent, separated or attached, is characterized for representative operating conditions. Instrumentation includes hot-wire anemometry and surface-mounted thin film sensors. When without wake passing disturbances, surface static pressure taps are used to document surface static pressure coefficient, Cp, distributions. With background turbulence present but without wakes, cases are run for TI levels of 1.0 and 20 % for chord Reynolds numbers of 40,000 and 80,000. These cases are repeated with wake generation at representative blade velocities. For documenting the approach flow, turbulence spectra and turbulence intensities are taken for the various TI levels and Re_C values with and without wake generation. From this, the integral length scales are computed. Measurements within the cascade include, on the suction surface, the transition location, the separation location, and the point of reattachment. Instruments for locating these regions are surface-mounted thin-film gages and a hot-wire sensor positioned very near the wall at various streamwise locations. To document the statistical quantities when operating with wake generation, rms fluctuation levels of an ensemble of records are taken behind the wakes and between the airfoils. They are encoded off the translation device and plotted versus t/τ (the dimensionless time within the wake passing period). These data are used to characterize the unsteadiness.

A PROGRAM PLAN FOR TRANSMITTING
HIGH-DATA-RATE ATM/SONET SIGNALS OVER THE ACTS

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Abstract

The feasibility, desirability and usefulness of Asynchronous Transfer Mode and Synchronous Optical Network transmission protocols over the Advanced Communications Technology Satellite (ACTS) was studied. A program plan for the transmission of Asynchronous Transmission Mode and Synchronous Optical Network signals at high data rates via the ACTS satellite was developed for the U. S. Air Force Rome Laboratory. The high data rate terminals will transmit and receive signals at DS-3 (45 Mbps) and OC-3 (155 Mbps) over the NASA's ACTS.

INTEGRATION OF CHAMP FIRM MACRO LIBRARY WITH DSS SYNTHESIS SYSTEM

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Abstract

With the current development of high-level synthesis tools such as MSS[1], there has been a significant reduction in design times for application-specific integrated circuits. Another recent development has been the introduction of FPGA (Field Programmable Gate Array) technology which is used for rapid-prototyping of processor designs. Since most high-level synthesis tools target an ASIC architecture, this summer's research project addressed the issue of using high-level synthesis tools to generate register level designs suitable for use on FPGA architectures.

AN INVESTIGATION OF CEPSTRUM BASED SPEAKER IDENTIFICATION ALGORITHMS TO DETERMINE THEIR DEPENDENCY ON THE SPOKEN LANGUAGE

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Abstract

The objective of this research effort is to determine to what degree the Rome Lab cepstral based speaker identification algorithms are language dependent. The approach taken uses the same cepstral based techniques that Rome Laboratory/IRAA has successfully used for the automatic identification of speakers and applies them toward the automatic identification of languages. The speaker identification algorithms extract several cepstrum based features and feeds them to various classifiers. The results of the classifiers are then adjudicated to determine the final classification. Training and testing was completed for ten languages. Different speakers were used in training and testing to insure that the algorithms are targeting the languages and not speakers. Several observations provide insight into the relationship between the speaker identification techniques and their ability to automatically identify the languages tested.

MILLIMETER WAVE-INDUCED HYPOTENSION DOES NOT INVOLVE HUMORAL FACTOR(S)

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Abstract

In ketamine-anesthetized rats, sustained whole-body exposure to 35-GHz millimeter wave radiofrequency radiation (RFR) produces hyperthermia, visceral vasodilation, and subsequent hypotension resulting in death of the subject (Physiologist 34:246, 1991). This study sought to determine whether this phenomenon (i.e., eradication of compensatory splanchnic vasoconstriction precipitating hypotension) is caused by vasodilatory factor(s) present in the circulating blood during circulatory failure. In search of evidence for a humoral visceral vasodilator, we performed a blood transfusion experiment. Two groups of rats (n=10 for each group) were used for the protocol. In the experimental group, one rat (donor rat) was exposed to RFR until mean arterial pressure (MAP) fell to 75 mmHg (arbitrarily assigned point of shock induction from previous work). At this point, 5 ml of blood were withdrawn from the hypotensive rat via the left carotid artery. This blood was subsequently infused into the recipient rat via the right jugular vein while an equal volume of blood was withdrawn simultaneously from the right femoral artery. MAP was monitored on the recipient rat for a 5 minute control period prior to transfusion and during the entire transfusion. In the control group, the same procedure was employed without exposing the donor subject to RFR. Therefore, in the control paradigm, the donor subject was normotensive when the blood was withdrawn. Immediately following transfusion in both groups, we observed an initial decrease in MAP followed by a similar increase returning MAP to control period levels. The recipient rats in the experimental paradigm did demonstrate a more pronounced decline in MAP post-transfusion as compared to the recipient rats in the control group (20.4 mmHg to 9.3 mmHg, respectively); however, those differences in mean maximum decrease in MAP were not shown to be significant ($p=0.051$). Therefore, we conclude that the vasodilatory factor(s) is not a humoral agent.

TRANSFERRING TECHNOLOGY VIA THE INTERNET

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Abstract

The current global economic climate is such that a nation acquires and maintains its wealth, prosperity, and strength predominantly through trade. It is necessary, but no longer sufficient, for a nation to possess a strong military function in a global marketplace. This new emphasis on national competitiveness in trade places Rome Laboratory, as well as other federal laboratories, at an important crossroads. On the one hand, a military advantage requires continual technological superiority. On the other hand, Rome Laboratory needs to facilitate national economic development through the transfer of its technologies into the marketplace. These developments serve to highlight the importance of a proactive technology transfer process within Rome Laboratory. However, a proactive operation is difficult to put into action without forthcoming budgetary and personpower increases. This study focuses on a low-cost alternative: to use MOSAIC on the Internet and the World Wide Web to promote the transfer and commercialization of technology. An electronic system was developed allowing access on various technology transfer information and databases to the private sector, as well as Rome Laboratory and other Air Force and public sector users. This report describes these efforts, underlying reconceptualizations, design and implications of the electronic system.

A STUDY OF THE USE PREDICTIVE MODELING
FOR DYNAMIC LOADING OF THE SPINE

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Abstract

The applicability of finite element modeling to predict the response of the cervical spine under high dynamic loading was studied. MRI images were to be used to build a 3-D geometry of individual pilots which would then be analyzed to determine the response of the spine to high G loading. However, it was found that a 3-D model could not be built from the images directly. In addition, the lack of data covering the responses of the spine under high dynamic loads prevented the building of a validatable model by hand. Although finite element modeling with a dynamic analysis would be able to predict the response of the spine, the following conditions must be met first: 1. further experiments must be conducted to ascertain the mechanical properties of the spine under high dynamic loads, 2. injury mechanisms from high dynamic loading must be better characterized so that a model can be validated acceptably, and 3. the medical images must be enhanced from what we had done.